APRIL 1956

PLASTICS TECHNOLOGY

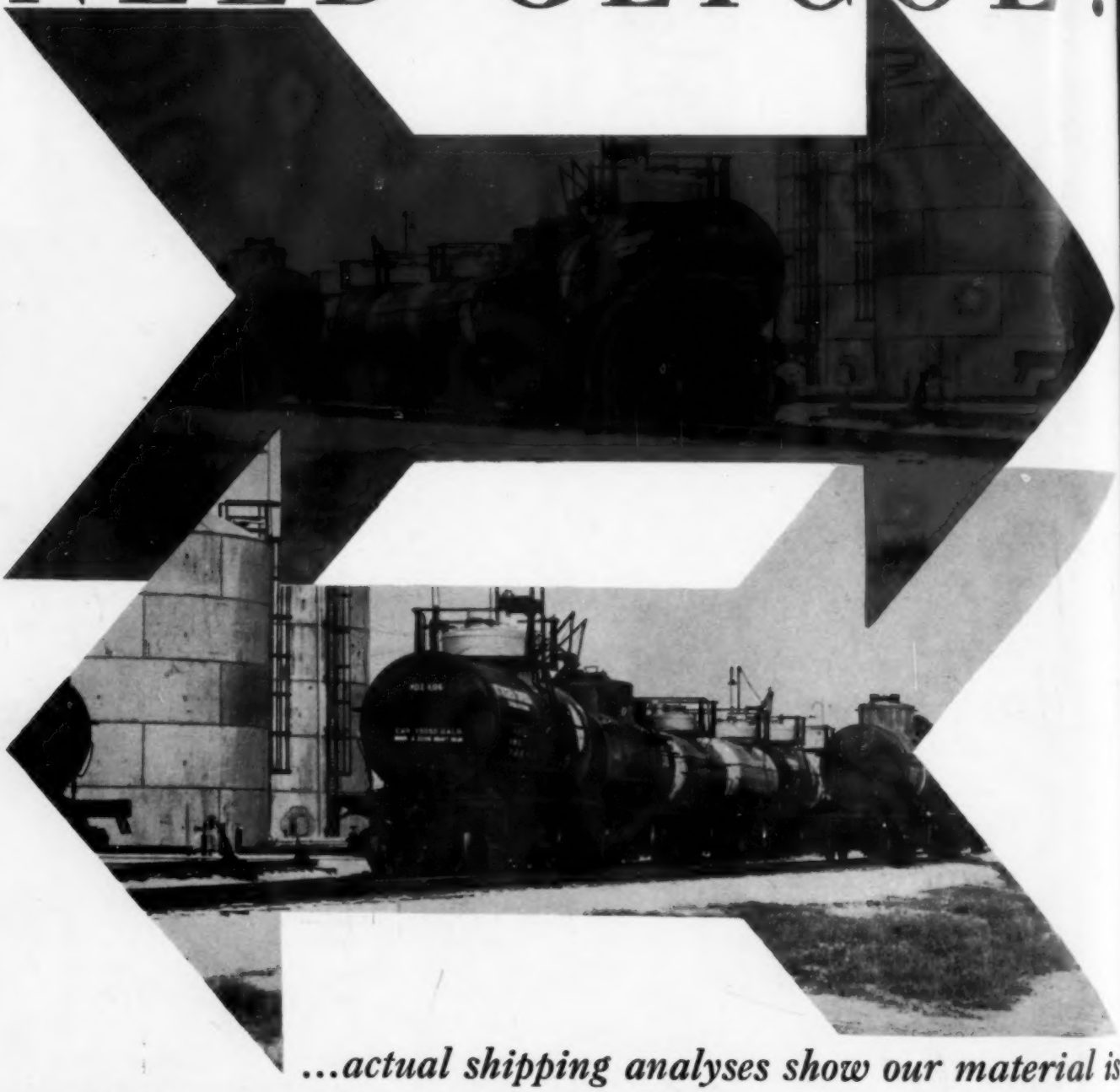
THE MAGAZINE OF APPLIED ENGINEERING

UNIVERSITY OF ILLINOIS
APR 2 1956
ENGINEERING

DU PONT'S NEW PLANT FOR CRONAR POLYESTER FILM BASE AT PARLIN, N. J.

A BILL BROTHERS PUBLICATION

NEED GLYCOL?



...actual shipping analyses show our material is low in iron, chlorides, acidity and water!

At our Orange, Texas plant – one of the world's most modern petrochemicals plants – we employ the most advanced processes to turn out ethylene, diethylene and triethylene glycol of the highest commercial purity. They are available in bulk from the plant in 4, 6, 8 and 10,000-gallon tank cars or barges – and in L.C.L. shipments (drums or tank trucks) from Edgewater, N. J.; New York, N. Y.; Boston; Chicago; Los Angeles; and other key industrial points.

Dept. G 2-23-1

Allied Chemical — NITROGEN DIVISION

40 Rector Street, New York 6, N. Y.

Write for a typical analysis, price quotation, free sample, or technical service.

CHEMICAL PROGRESS WEEK — APRIL 23-28

A Better America Through Chemical Progress

Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Tetroxide • Nitrogen Solutions • Fertilizers & Feed Supplements

PLASTICS TECHNOLOGY, published monthly by BILL BROTHERS PUBLISHING CORPORATION. Office of Publication, 1309 Noble Street, Philadelphia, Pa., with Editorial and Executive Offices at 386 Fourth Avenue, New York 16, N. Y. Subscriptions in United States and possessions and Canada $4.00 per year. All other countries $8.00. Accepted as controlled circulation publication at Philadelphia, Pa. Copyright 1956 by Bill Brothers Publishing Corporation

THE MAGAZINE OF APPLIED ENGINEERING

PLASTICS TECHNOLOGY

CO-PUBLISHERS
EDWARD LYMAN BILL
RAYMOND BILL

FREDERICK C. KENDALL
Vice President

•

EDITORS
ARTHUR M. MERRILL
Editor

ROBERT G. SEAMAN
Executive Editor

JAMES T. DUGAN
Assistant Editor

BARBARA GEERLINGS
Editorial Assistant

L. THAKAR
Foreign Editor

EDITORIAL ADVISORY BOARD

Materials
C. H. ADAMS
D. L. SCHOENE
G. B. THAYER

Moldmaking
E. J. CSASZAR

Processing
SAUL BLITZ
JOHN BOLTEN, JR.
H. T. DOUGLAS
A. A. KAUFMAN
J. H. WOODRUFF

Equipment
H. E. BUECKEN
A. J. DEMATTEO
E. H. JOHNSON

•

BUSINESS STAFF
JAMES L. CONKLIN
Business Manager

WILLIAM T. BISSON
Mid-West Sales Manager
244 Water Street, Akron 8, Ohio
FRanklin 6-8187

C. E. LOVEJOY, JR.
Western Manager
333 N. Michigan Ave., Chicago 1, Ill.
STate 2-1266

ROBERT E. AHRENSDORF
Pacific Coast Representative
1140 Wilshire Blvd., Los Angeles 17
MAdison 9-2681

ALBERT R. WILSON
Circulation Manager

FRANCES Y. McHUGH
Production Manager

APRIL 1956

VOLUME II, NUMBER 4

ZYTEL AND TEFLON RESINS AS BEARING MATERIALS — PART I
A. J. Cheney, Jr., W. B. Happoldt, and K. G. Swayne 221
The beginning of a two-part article discussing the properties of these resins that make them advantageous for bearing applications.

PRODUCTION OF RIGID THERMOPLASTIC SHEETS ... Edward C. Brown, Jr. 226
A discussion of materials, equipment, and operations for making sheets by calendering and extrusion.

INJECTION MOLDING MACHINE STANDARDS ..... A. J. De Matteo 231
A GUEST EDITORIAL

FORMING OF RIGID THERMOPLASTIC SHEET ..... Robert C. Davenport 232
An analysis of mold materials, mold design, and methods for post-forming rigid thermoplastic sheets.

HIGH-QUALITY PLASTICS COMPONENTS FOR GUIDED MISSILE AND AIRBORNE RADAR SYSTEMS ..... W. Crofut and L. B. Keller 237
Uniform and reliable plastic parts can be made only with adequate raw material inspection, accurate process control, and proper part inspection.

VINYL FOAMS MADE BY ATMOSPHERIC-PRESSURE METHOD 246

PLASTIC GEODESIC SPHERE 247

FEATURE DEPARTMENTS

Letters to the Editor	206	New Materials	259
News in Brief	215	New Equipment	262
Editorial	217	New Products	264
News of the Societies	248	New Literature	266
Calendar of Coming Events	274	Book Reviews	268
News of the Industry	251	Abstracts of Important Articles	269
News from Abroad	256	Patent Digest	271
Names in the News	257	Resins: Production and Sales	273
"Quote . . . Unquote"	208	Current Market Prices	275

Published monthly by

BILL BROTHERS PUBLISHING CORPORATION

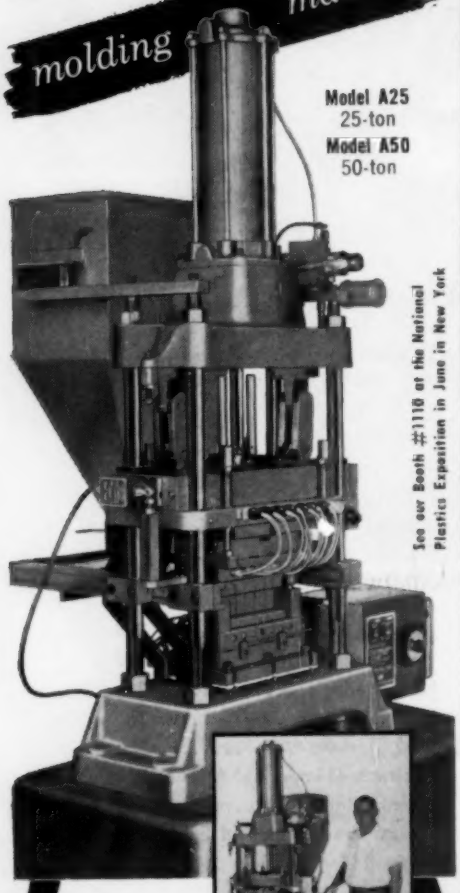
386 Fourth Avenue, New York 16, N. Y.

BILL BROTHERS PUBLICATIONS

Chairman of the Board, Raymond Bill. President, Edward Lyman Bill. Treasurer, Ralph L. Wilson. Vice Presidents, B. Brittain Wilson, C. Ernest Lovejoy, Wm. H. McCleary. Editorial and Executive Offices, 386 Fourth Ave., New York 16, N. Y. LExington 2-1760. Subscription Price: United States and Possessions and Canada, $4.00 per year. All other countries, $8.00. Single copies in the U. S. 50¢; elsewhere, 75¢; Other Bill Brothers Publications: In Industry: Rubber World. In Marketing: Sales Management, Sales Meetings, Premium Practice. In Merchandising: Floor Covering Profits, Fountain & Fast Food, Grocer-Graphic, Tires-TBA Merchandising, Yankee Grocer.

NEW!
AUTOMOLD
FULLY AUTOMATIC
high speed
compression
molding machine

Model A25
25-ton
Model A50
50-ton



See our Booth #1110 at the National Plastics Exposition in June in New York

Needs no operator. Cycles continuously. Just adjust to start – refill with raw material as needed–then remove a constant stream of finished products.

Lowest first and maintenance costs. Free counsel on mold design and production. Write for brochure on 25 and 50 ton models. Some territories still open for representatives. Contact

AUTOMATIC MOLDING MACHINE CO.
3217 Exposition Pl., Los Angeles 18, Calif., Dept. F

Letters to the Editor

Letter and Reply

Dear Sir:

My attention has been drawn to the article, "Stabilizers for Vinyl Chloride and Its Copolymers," by Matthew Perry and Paul F. Bruins, which appeared in your November and December 1955 issues.

May I point out that substantial portions of this article have been taken from a series published in "British Plastics" in May, June, and August 1954, entitled "Stabilisers for Vinyl Polymers," by H. Verity Smith. In a number of instances your authors have quoted word for word from the articles by Verity Smith. Although it is true that in their bibliography they have listed the articles in "British Plastics," it seems to me that this is inadequate acknowledgment.

I hope that you will publish this letter in order to show the debt which you authors owe in drawing so heavily on Verity Smith's articles.

Phillip Morgan, Editor
"British Plastics"
London, England

Dear Sir:

We are glad to acknowledge the valuable help that we received from the articles by H. Verity Smith which were published in "British Plastics" in 1954, concerning "Stabilizers for Vinyl Polymers."

Mr. Smith's article emphasized the chemical and theoretical aspects of the stabilizer systems. Our article was an attempt to review the literature on vinyl stabilizers and bring it up-to-date. The emphasis was on the technological aspects, with the broadest possible coverage.

Our article was based on many other sources of information, and also included the results of extensive test work done by the authors.

Matthew Perry, Chief Chemist,
Niemand Bros., Inc., Long Island City, N. Y.,
and
Paul F. Bruins, Professor of Chemical Engineering,
Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

• • •

Polyethylene Nomenclature

Dear Sir:

Your editorial in PLASTICS TECHNOLOGY for February put a finger on an important question and one to which we have given much consideration in Du Pont. Perhaps you would be interested in the point of view we have developed as a result of familiarity with most of the polyethylenes you mentioned, as well as some others, over a period of many years.

In general, we feel most strongly that a product should be described or defined or named by reference to its properties and not to its origin. By this we mean that a product should be recognizable in terms of some test or measurement that can be made on it without knowledge of the process by which it was made. This reflects our point of view that performance is the question of paramount interest to those who read about polyethylenes in your excellent magazine and in the technical literature generally.

One weakness of naming a product with an expression that relates to the process by which it was made is that the process may change as technology evolves without change of the product.

In the present instance, there is a particularly compelling reason why the term "low-pressure" is not suitable to designate linear polyethylenes. This is the fact that linear polyethylenes can be made by polymerization at very high pressures. Indeed, the first linear polyethylene ever seen, to our knowledge, was made this way. An account of this discovery in our laboratories will be presented at the American Chemical Society meeting in Dallas in April.

We quite agree with your assertion that "polyethylene" cannot be considered at all for a molecule made from ethylene.

All things considered, we believe that "high-density" is the most appropriate designation for the material we are talking about. As you so aptly point out, this alone does not distinguish between linear polyethylenes from various sources, but I believe that when whatever differences there may be among them become known, it will be relatively easy to add further property qualifications to the basic name "high-density" to provide the appropriate distinction.

As far as copolymers are concerned, why not call them "copolymers," with added terms relating to stiffness, flow properties, etc., to differentiate among them as needed.

Frank C. McGrew,
Asst. Research Director,
E. I. du Pont de Nemours & Co.
Wilmington, Del.

(Any further comments from our readers?—Editor.)

• • •

Disagrees with Talbert

Dear Sir:

We would like to comment on Norbert E. Talbert's article, "Reinforced Epoxy in Airline Tray Carriers," in the February issue of your magazine. His comment as to weight of the polyester Airline Tray is misleading. As developers of the first integrally-molded, solid polyester-fiberglass unit and as manufacturers of more than 1,000 units of the same, we feel obligated to point out that the above completed units weigh 16 pounds each.

M. Rubin & N. Diaz
Steiner Plastics Mfg. Co., Inc.
Glen Cove, N. Y.

(In his article, Mr. Talbert stated that "a comparable carrier made wholly of standard 1/8-inch thick reinforced polyester laminate weighs about 20 pounds." —Editor)

• • •

Additions to Price List

Dear Sir:

We have manufactured and supplied stabilizers to the vinyl plastics industry since 1948. Our current price list is enclosed.

W. D. Mitchell, Sales Dept.,
Ferro Chemical Corp.,
Bedford, Ohio

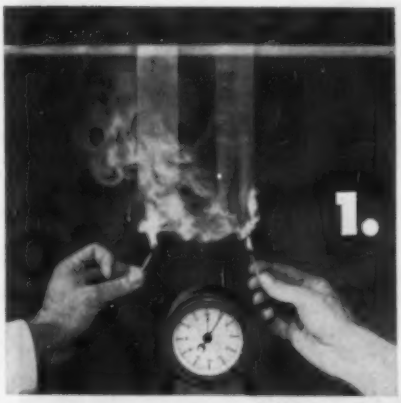
(This letter is being printed to remind all supplier companies, whether subscribers or not, that we would like to include their products in our market price listing.—Editor)

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation, and address.

Letters requesting information on technical or engineering problems will be printed to elicit replies by the readers, either directly or through these columns. Upon request the identities of such "problem" letters will not be divulged.

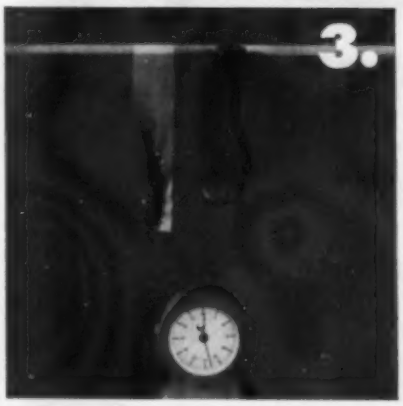
—The Editor

Here is a FLAME RETARDER with Low Tinctorial Strength



FLAME WAS APPLIED to two vinyl plastic sheet samples of the same formulation, except that sample at left contained M & T Flame Retarder.

FIVE SECONDS AFTER removal of matches, protected plastic had stopped burning, unprotected sample continued to burn fiercely.



AT THE END OF TEST, unprotected sheet was reduced to black ash.

Here is proof that M & T Flame Retarder readily retards combustion when combined with organic, chlorine-containing compounds. Easily blended throughout the material it protects, M & T Flame Retarder has approximately one-fifth the tinctorial strength of Antimony Oxide, making it ideal for semi-transparent stocks. Considerable savings of expensive basic pigments can be made in processing deep colors.

For applications where low tinctorial strength is not required, *M & T Plastic Grade Antimony Oxide* is recommended.

Both M & T Flame Retarder and Antimony Oxide are control graded to assure consistent results from batch to batch. Write for information on these products or call on M & T's research facilities available to help you with your flame-proofing and fire-retarding problems.

TIN & TIN CHEMICALS
CERAMIC MATERIALS
ORGANIC COATINGS
WELDING SUPPLIES
RADIOGRAPHIC EQUIPMENT
PLATING MATERIALS
METALS & ALLOYS
HEAVY MELTING SCRAP

"First Name in Tin Chemicals"

METAL & THERMIT CORPORATION

100 EAST 42nd STREET • NEW YORK 17, N. Y.

IMPORTANT NOTICE!

Every drum and bag of CIBA *Epoxy* RESINS carries this exclusive double check

To all users of this basic and widely used class of resins, the development of which was pioneered by CIBA researchers, rigid **manufacturing** and **applicational** control of Araldite Epoxy Resins *at the source of their production,* means utmost assurance of quality and uniformity. For further information on how CIBA Epoxies may lead to product improvement and new product development for you, write . . .

Ciba Company Inc., Plastics Division,
627 Greenwich St., New York 14, N.Y.

C I B A

ARALDITE® Epoxies

"Quote . . . Unquote"

The Shortage of Engineers

"The current shortage of engineers isn't anything new . . . but recent figures show it has reached critical national proportions. They show, for instance, that at least one industrial company out of every three in this country is suffering from an acute shortage of engineers. And in these days when technical progress is so urgently needed, almost half the companies who must make those forward steps tell us that their necessary expansion of research and engineering development is being greatly hampered due to a shortage of the right kind of people, capable engineers.

"It wouldn't be quite so serious if we knew this to be merely a temporary condition with some relief definitely in sight. But the facts are all in the other direction. To have a supply of capable engineers coming along, we need to start with high school graduates who have had a good grounding in mathematics and the sciences. But . . . here are some current figures:

50% of our high schools offer no courses in chemistry.

53% of our high schools offer no courses in physics.

Only 24% of all high school students study algebra (in 1900, it was 56%).

Only 11% of all high school students study geometry (27% in 1900).

Only 4.3% of them study physics (as compared to 19% in 1900)."

W. C. Newberg, President
Dodge Div., Chrysler Corp.
Detroit, Mich.

• • •

Horizons for Plastics

"Despite the great increase in the sales of synthetic resins and plastics during post-World War II years, we believe the surface of the market has barely been scratched. Plastics have become a part of our pattern of living.

"Today, the average seven-cubic foot refrigerator contains 22 pounds of plastic components, compared with one pound in a typical 1935 model. The average automobile today has an estimated 20 pounds of plastics, as opposed to 7½ pounds per car in 1941. The amount of plastics used by the average American family has increased from nine pounds in 1940 to 83 pounds in 1955. Within the next five years, this is expected to reach over 150 pounds.

"We feel that the plastics industry today is in about the same position on the industry life curve as was the steel industry in 1880. Then, there were horizons unlimited for steel; today, there are horizons unlimited for the chemical-plastics industry."

Roy C. Ingersoll, President
Borg-Warner Corp.
Chicago, Ill.

• • •

NEWS in BRIEF

Plastic wall tile industry has undertaken an extensive public relations and merchandising program. Designed to extend the market for quality tile, the program stresses the use of the government commercial standard on plastic wall tile by customers and the trade in general to evaluate their needs.

Major nomenclature changes for its Lustrex styrenes have been made by Monsanto. The three general-purpose grades are now named Lustrex Hi-Flow 55, 66, and 77; while the three rubber-modified, high-impact grades are now designated Lustrex Hi-Test 88, 88A, and 88B.

Standardization program on injection machines has received cooperation from all phases of the plastics industry, according to A. J. De Matteo, chief engineer of Watson-Stillman. The work has been done primarily by the machine builders, but they have had valuable assistance from users, a mold base manufacturer, and research work by a major chemical company.

Divisional changes in plastics companies noted this month included the establishment of a development company division by Union Carbide; the organization by Grace of a new polymer chemicals division; and the merging of its coal chemicals and plasticizers divisions by Pittsburgh Coke & Chemical into a new industrial chemicals division.

Company acquisition in the plastics field was the sale of Pacific Plastics Co. to Durabilt Luggage Co., both of Seattle, Wash. Durabilt culminated its development work on reinforced plastic luggage by the purchase of the glass-reinforced plastics manufacturing firm.

Flood of company expansions in the plastics industry remains unchecked. Borden is building a new PVC plant at Leominster, Mass. Dow's new biochemistry lab building was opened in Midland, Mich. Du Pont's new Parlin, N. J., plant for Cronar polyester film base is on stream. Construction has begun on Grace's new polyethylene plant near Baton Rouge, La. Full-scale production has started at Kopper's Port Arthur, Tex., polyethylene plant. Macco Chemical purchased a new, large plant for plastic wall tile adhesives in Wickliffe, O. Mobay plans to triple the size of its New Martinsville, W. Va., urethane chemicals plant. Nopco is erecting a new plant for plastic foams in North Arlington, N. J. Shell Chemical is building a new epoxy resin unit at its Houston, Tex., plant. A new custom molding firm, Southern Plastics, has occupied its new plant in Greensboro, N. C. A new Canadian subsidiary has been established by F. J. Stokes Machine. A new plant tripling its reinforced plastics capacity has been completed by Thompson Fiber Glass at Inglewood, Calif. Witco Chemical has installed a complete pilot plant for urethane foams at its Emulsol Division labs in Chicago, Ill.

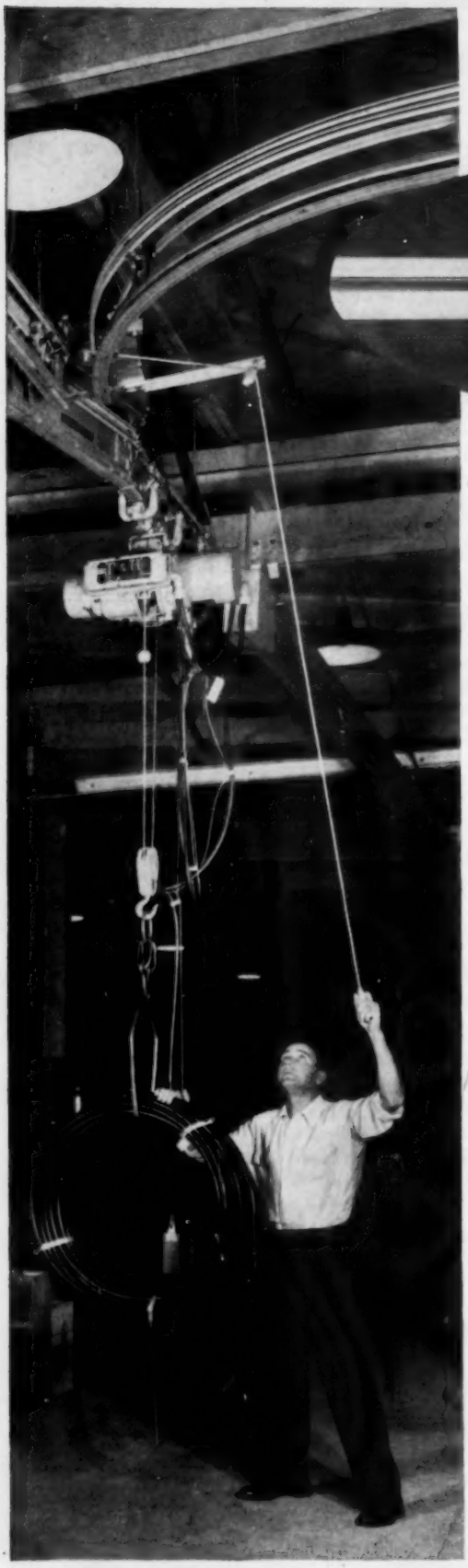
New Materials worthy of mention (see pages 259-61): filled epoxy paste for void-filling; primary and secondary plasticizers for vinyls; epoxy resin for troweling and splining; electrical-grade polyethylenes; monomer dispersant for vinyl plastisols; two liquid hardeners for epoxies; film-grade polyethylenes; formaldehyde-condensation powder for in-place foaming; polymerizable epoxidized olefins; and intermediate for epoxy and phenolic resins.

New Equipment to be noted (see pages 262-3): a series of double-acting cylinders; small-scale horizontal pumps; slab leveler-splitter and double-head splitter for polyurethane foam; a plasticizing extruder; single-flow rotary joints; and self-locking drill press clamps.

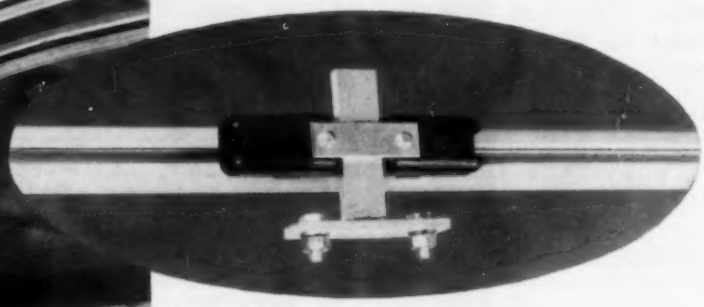
New Products of interest (see pages 264-5): polyethylene labware; fluorocarbon-glass laminate tank lining; extruded polyethylene drum liners; one-piece polyethylene chemical tanks; plywood sheets with fused cellulose acetate coating; polyethylene armrest covers for automobiles; extruded polystyrene diffusion shields for fluorescent lights; and molded polyethylene insulators for electric fences.

Another new development using

B. F. Goodrich Chemical *raw materials*



B. F. Goodrich Chemical Company does not manufacture this extrusion. We supply only the Geon rigid vinyl materials.



Rigid Geon packs power in small space

NAKED wires on an overhead power lift are a hazard, lose power along the line and have to be spaced widely where multiple electrical contacts are needed in large plants. As a product improvement, a manufacturer has designed U-shaped extruded insulation made of Geon rigid vinyl that has many advantages for the job.

The rigid vinyl extrusion carries a metal contact conductor safely so that as many as three to twelve power lines can be installed close together where space is tight. Because this insulation is made of Geon rigid vinyl it has high dielectric strength, high insulation resistance with low power loss. It has good chemical and abrasion resistance, necessary for long life in industrial plants and it can be colored according to local code requirements.

This installation you see here is a good example of a new use for Geon rigid vinyl. It may suggest a new use to you or may give you an idea for another saleable product. There are scores of other uses for Geon materials from rigid sheeting to rigid pipe and fittings. For technical help in the uses of versatile Geon please write Dept. DX-2, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

GEON RESINS • GOOD-RITE PLASTICIZERS . . . the ideal team to make products easier, better and more saleable.

GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors

PLASTICS TECHNOLOGY

APRIL, 1956

EDITORIAL: Sharing Industry Responsibilities—I

The plastics industry operates in theory on a simple and straight-forward system. The materials supplier company sells its plastic materials to the molder or fabricator. He, in turn, processes the materials into usable forms or shapes, and sells the resulting products to the user. In this system, both the materials suppliers and the processors are part of the plastics industry and have related stakes in the service success or failure of the finished plastic parts.

This partnership of suppliers and processors entails certain responsibilities. The supplier must provide the processor with honest comprehensive information on his materials and their processing conditions. On the other hand, the processor must choose the right material for the application at hand, and process it properly so as not to impair its properties.

In actual practice, however, both partners often ignore their responsibilities.

•

The first responsibility is that of the materials suppliers, and is almost completely ignored in actual practice. Each supplier appears intent only on presenting his materials in the most favorable light; for himself, that is, not for his processor partner. The obvious inference is that the supplier wants to sell his materials, regardless of the processor's trials and tribulations.

Of course, this attitude is denied vehemently by the suppliers, and the sin may be more one of omission than commission. But regardless of all the good intentions of materials suppliers, what do we find in actual practice?

A plastic material is presented in its favorable aspects; "good" properties are emphasized, while "bad" properties are soft-pedaled or ignored. The same material may be made by two or more suppliers, but the processor must determine this similarity only by experience, because most of the data given him by the suppliers cannot be compared because of differing test conditions or apparatus, and sometimes these differences are not apparent to other than the expert eye.

Information on molding conditions or limitations is usually quite complete as received from the supplier. But even here, these conditions or limitations are not always spelled out in sufficient detail to insure comprehension by the processor.

•

Since this is a partnership, both sides must be examined. As indicated in next month's continuation of this editorial, the processors are far from blameless.

Arthur M. Merrill

Editor

A TECHNICAL REPORT from Du Pont

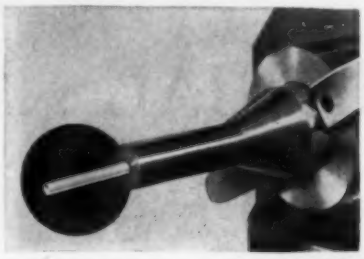
• *Properties and application data on* Teflon® *tetrafluoroethylene resin*

Chemical inertness and exceptional thermal stability are high on the list of advantages of Du Pont "Teflon" tetrafluoroethylene resin. The toughness and excellent dielectric properties of this engineering material add further to its versatility.

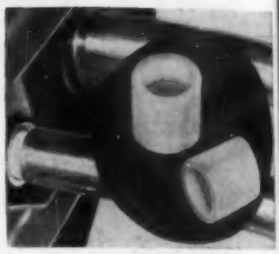
"Teflon" is nonflammable, and has zero water absorption by ASTM test D570-42. Often useful is its non-adhesive quality . . . materials will not stick to its surface. On the right, you see how engineers have made use of the unique properties of "Teflon" in three typical product improvements. Property data for Du Pont "Teflon" is shown below.

Take a close look at "Teflon" to evaluate it in terms of your own product design problems. For further information on "Teflon" write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 494, Du Pont Building, Wilmington 98, Delaware. In Canada: Du Pont Company of Canada Limited, P.O. Box 660, Montreal, Quebec.

Pipe coupling uses flexible bellows of "Teflon." Flexibility of "Teflon" compensates for misalignment between pipe connections, and absorbs vibration. None of the chemicals normally found in industry affect "Teflon."



Extruded hose material of "Teflon" is strong, flexible, corrosion-resistant—assures long, trouble-free service. "Teflon" is unaffected by solvents and has a useful temperature range of —450°F. to 500°F.



Tough bushings of "Teflon" are used on this textile dyeing machine which operates under high-temperature conditions and pressure. The bushings are not corroded by the dyes, and do not distort from the heat or pressure. They require no lubrication.

MECHANICAL PROPERTIES			METHOD
Tensile Strength	73°F.	1,800 p.s.i.	D638-52T
	170°F.	1,100 p.s.i.	D638-52T
Elongation	73°F.	110%	D638-52T
	170°F.	600%	D638-52T
Modulus of elasticity	77°F.	58,000 p.s.i.	D638-52T
Shear strength		3,800 p.s.i.	D732-46
Impact strength, Izod	—70°F.	2.0 Ft.-lb./in.	D256-47T
	73°F	3.0 Ft.-lb./in.	D256-47T
Stiffness	73°F.	60,000 p.s.i.	D747-50T
Flexural strength	73°F.	Did not break	D790-49T
Compressive stress at 1% deformation		600 p.s.i.	D695-52T
Creep in flexure		67	*
Hardness, Durometer		D50-D65	D676-49T
Static or kinetic coefficient of friction against polished steel		0.04	Various methods used

THERMAL PROPERTIES		
Coefficient of linear thermal expansion per °F.	5.5×10^{-5}	D696-44
Thermal conductivity	1.7 B.T.U./hr./sq.ft./°F./in.	Measured by Cenco-Fitch
Specific heat	0.25	
Deformation under load at 122°F., 2000 lb./sq. in., 24 hrs.	25%	D621-48T
Heat-distortion temperature 264 lb./sq. in.	140°F.	D648-45T
66 lb./sq. in.	250°F.	D648-45T

ELECTRICAL PROPERTIES		
Dielectric strength, short-time, 0.080 in.	400-500 v/mil	D149-44
Volume resistivity	$> 10^{15}$ OHM-CM	D257-52T
Dielectric Constant, 60 cycles	2.0	D150-54T
10^3 cycles	2.0	D150-54T
10^6 cycles	2.0	D150-54T
10^9 cycles	2.0	D150-54T
Power factor, 60 cycles	< 0.0003	D150-54T
10^3 cycles	< 0.0003	D150-54T
10^6 cycles	< 0.0003	D150-54T
10^9 cycles	< 0.0003	D150-54T

CHEMICAL PROPERTIES	
Resistant to:	all chemicals except molten alkali metals and fluorine (under elevated temperatures and pressures)

MISCELLANEOUS PROPERTIES		
Water absorption	0.005%	D570-42
Flammability	nonflammable	D635-44
Specific gravity	2.1—2.2	D792-50
Resistance to weathering	excellent	D392-38
Basic color	light opaque	—

*Term "creep in flexure" is a measure of the deformation under a prolonged standard load. Results here represent mils deflection in 24 hrs. of a 1/8" x 1/2" bar, 4" span, center-loaded flatwise to 1000 lb./sq. in., minus the initial deflection.

NOTE: This table shows the typical property data for Du Pont "Teflon" tetrafluoroethylene resin.

ZYTEL® nylon resin · **ALATHON®** polyethylene resin · **TEFLON®** tetrafluoroethylene resin · **LUCITE®** acrylic resin

DU PONT
REG. U. S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

NOW . . . FASTER DELIVERIES !

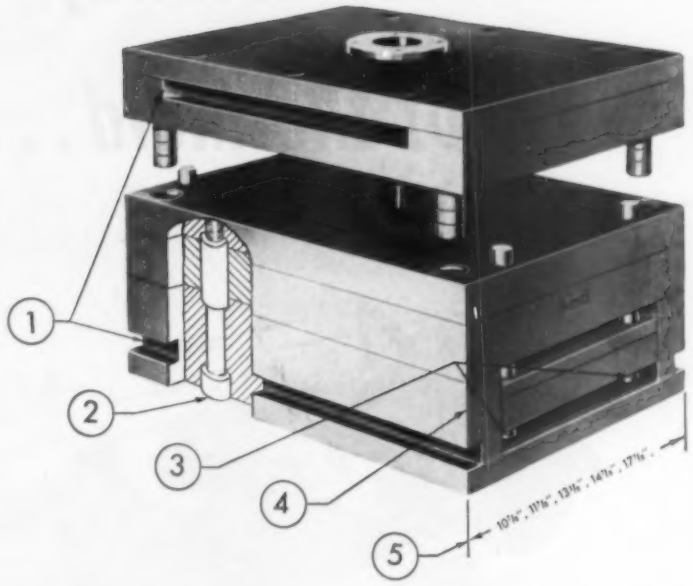
ON D-M-E STANDARD MOLD BASES!

EXPANDED FACILITIES SAVE YOU TIME . . !

Now . . . you can get FASTER DELIVERIES on the highest quality Standard Mold Bases even though the demand has reached an all time high!

This availability has been made possible by the recent expansion in D-M-E's manufacturing facilities. With D-M-E's Hillside, New Jersey plant doubled and additions at the Detroit, Michigan plant completed, production of Standard Mold Bases is now geared to meet the ever-increasing demands of the Industry.

This increased production has enabled D-M-E's FIVE BRANCH WAREHOUSES to replenish their stocks and provide IMMEDIATE DELIVERIES on a wide range of standard sizes . . . This means ADDED SAVINGS in mold construction time as well as ECONOMY in mold costs for you!



(9" wide series available with clamping ledges and solid dowels.)

4,400 COMBINATIONS SAVE YOU MONEY . . !

22 Standard Width and Length combinations . . .
From 9" x 8" to 17⅞" x 35½"

100 Cavity Plate Combinations . . .
From ⅞" thick to 5⅞" thick

2 Special Types of Steel . . .

DME No. 1 Steel —
Medium Carbon, silicon killed

DME No. 2 Steel —
SAE 6145, electric furnace grade, preheat treated to 225 Brinell.

For complete data and prices . . .
CONSULT YOUR NEW D-M-E CATALOG!

YOU GET TOP QUALITY PLUS THESE ADDED FEATURES!

1. **CLAMP SLOTS to Save Platen Space**
   Eliminates space-wasting "clamping ledges"
2. **MORE ROOM for Waterlines**
   Tubular Dowels eliminate obstruction
3. **STOP PINS WELDED to Ejector Bar**
   Prevents loosening and ejection interference
4. **RIGID CONSTRUCTION with Less Parts**
   One piece Ejector Housing gives added strength
5. **NEW WIDTHS Fit More Molding Machines**
   Allows more cavities to existing platen area

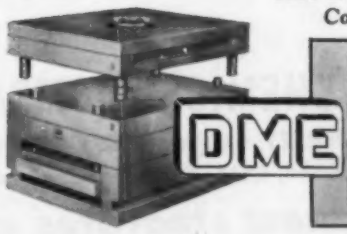
CONTACT YOUR NEAREST D-M-E BRANCH . . . TODAY!

DETROIT MOLD ENGINEERING CO.

6686 E. McNICHOLS ROAD — DETROIT 12, MICHIGAN — TWinbrook 1-1300

Contact Your Nearest Branch FOR FASTER DELIVERIES!

D-M-E MASTER LAYOUTS are available for each of the 22 different Standard Mold Bases sizes! See Page 164 of your D-M-E Catalog for complete ordering information.



DME

HILLSIDE, N. J. (NEAR NEWARK) 1217 CENTRAL AVE., ELIZABETH 3-5840
CHICAGO 51, ILLINOIS 5901 W. DIVISION STREET, COLUMBUS 1-7855
CLEVELAND 9, O.-D-M-E CORP. 502 BROOKPARK RD., SHADYSIDE 1-9202
LOS ANGELES 7, CAL. 3700 SOUTH MAIN STREET, ADAMS 3-8214

Jeep produced by Thomas Mfg. Corp.
from mold made by Newark Die Co.

For Fast Getaway Out of the Mold...

...use

METASAP® STEARATES

The tough jobs come out of the mold easier when you use Metasap stearates. You get faster production—and a better molding job too! Simply mix Metasap stearate right in with the plastic as you dry-color it...or occasionally dust the mold with a stearate powder bag.

You'll find the stearate acts as mold lubricant—reduces sticking...helps the plastic to flow quicker. You use lower ejection pressures that boost production and cut down rejects. Molds last longer too!

Get all the facts on Metasap stearates—how they help you make more profit on every order. Our Technical Service will gladly help you pick the specific Metasap stearate that will do the best job for you. Write today for FREE information.

Want ECONOMICAL plastigels?

A complete line of Metasap stearates available as thickening agents for plastigels. We'll gladly send you FREE experimental samples of magnesium, calcium and aluminum stearates. Write now for immediate shipment.

METASAP CHEMICAL COMPANY

METASAP CHEMICAL COMPANY
HARRISON, NEW JERSEY • Chicago, Ill. • Boston, Mass.
Cedartown, Ga. • Richmond, Calif. • London, Canada

the cleanest stearates made

A NOPCO Subsidiary

Zytel and Teflon Resins as Bearing Materials*—Part I

The beginning of a two-part article discussing the properties of these resins that make them advantageous for bearing applications.

A. J. CHENEY, JR., *Sales Technologist,*
W. B. HAPPOLDT, *Supervisor of Sales Service Laboratory,*
and
K. G. SWAYNE, *Research Engineer,*
E. I. du Pont de Nemours & Co.
Wilmington, Del.

Both Zytel nylon resin and Teflon tetrafluoroethylene resin are being used extensively as bearing materials. Most of these applications have been developed independently, and no attempt has been made to collect performance data in order to put future design on a firm basis.

Typical data on dry or partially-lubricated bearings have been collected from a variety of sources. Data on the coefficients of friction by various tests have been reported by a number of investigations. Since the results depend upon the apparatus used, these cannot be compared except for similar test conditions. Pressure times velocity (PV) values can be used in the design of dry or partially-lubricated bearings over a wide range of operations.

Work in our laboratories on lubricated bearings made of Zytel is reported for the first time. It was found that hydrodynamic lubrication can be maintained with very low quantities of lubricant. The results of this work are compared to present bearing theories.

In addition, physical properties of these materials are described. With these properties and the bearing work done to date, it is believed that the selection of the material and the design of bearings can be done with greater accuracy.

Teflon Resin

Teflon tetrafluoroethylene resin possesses a number of properties which make it an interesting bearing material. The most important, of course, is that under certain conditions a very low coefficient of friction (approximately 0.04 or less) can be obtained with non-lubricated bearings. Low coefficients of friction can be obtained even with compositions containing fillers to improve the wear properties.

* Based on a paper presented at the annual meeting, Society of Automotive Engineers, Inc., Detroit, Mich., January 9, 1956.

Table 1. General Properties of Molded Teflon.

Melting point, °F.	620
Upper Service Limits, °F.:	
Continuous	500
Intermittent	620
Coefficient of thermal expansion, in./in./°F.	5.6 x 10 $^{-5}$
Linear increase, in./in., at transition point @ 70° F.	0.004
Thermal conductivity, BTU/hr.sq.ft./°F./in.	1.7
Hardness:	
Rockwell	J75-95
Durometer	D50-65
Knoop	2.8
Compressive strength for 1% deformation at 73° F., psi.	600
Fatigue endurance limit at 73° F., psi.	760

General Properties

Before considering bearing properties, we can review the general properties of molded Teflon, and most of these properties are listed in Table 1. Teflon melts at 620° F., the highest melting point of any thermoplastic. It has excellent stability to heat, and can be used continuously at temperatures up to 500° F. and intermittently up to 620° F. Strength and hardness properties are also shown in the listing. Because it is a soft but tough material, it will embed the hard foreign contaminants that are often found in a bearing.

Teflon also is inert to a wide range of chemicals and solvents. Except for a few chemicals seldom encountered in industry, such as molten alkali metals and fluorine at elevated temperatures and pressure, parts made from this material will neither be affected by nor contaminate their environment. In addition, water has no effect on this material.

Various combinations of Teflon with reinforcing agents such as graphite or powdered glass are commonly used for bearings and other mechanical applications which require good resistance to wear. In general, the physical properties of these combinations are the same as those of straight Teflon, except that the reinforced stocks have much better resistance to deformation and wear.

Short-time deformation properties, as measured by flexural modulus, are shown in Figure 1. The modulus is a function of the temperature and the amount of additive used. The ratios of the two compositions containing graphite are by weight. If the modulus of any given composition is known at one temperature, the value can be estimated accurately for other temperatures from this chart since the lines are parallel.

As with many materials, the moduli in flexure, tension, and compression are essentially the same. Therefore, the compressive stress required to give 1% deformation for the modified compositions increases in the same proportion as the modulus. For example, the 1:1 Teflon-graphite composition has a modulus three times that of unmodified material, therefore, the compressive stress at 1% deformation is three times 600 or 1,800 psi. for this material.

A. J. Cheney, Jr.

W. B. Happoldt

K. G. Swayne

Azro Jackson Cheney, Jr., attended Ohio State University and Cornell University, receiving his B.S. in chemical engineering in 1940, and his master's degree in 1942. He joined Du Pont in 1942 as research engineer, becoming plant development engineer in 1948, assistant technical superintendent in 1951, and being named to his present position in 1953. All of his work in research, plant development, and sales has been concerned with Teflon or Zytel. A member of SPE and ACS, Mr. Cheney resides in Wilmington with his wife and three children.

William B. Happoldt received a B.S. in Chemistry from the College of Charleston in 1937 and a Ph.D. in organic chemistry from the University of North Carolina in 1941. With Du Pont since 1941, he has served as a research chemist (1941-46), research group leader (1946-50), research supervisor (1950-52), product specialist in sales (1952-55), and supervisor of the sales service lab since 1955. All of his work with Du Pont has been chiefly on Alathon polyethylene resin and Teflon tetrafluoroethylene resin. He is a member of ACS. A resident of Claymont, Del., Dr. Happoldt is married and has two children.

Kenneth Gilbert Swayne attended Lehigh University, receiving a B.S. in mechanical engineering in 1943 and an M.S. in 1948. He joined Du Pont in 1953, after having been a test engineer with General Electric Co. (1943-44), assistant engineer with Tennessee Eastman at Oak Ridge, Tenn. (1944-45), an electronic technician in the Navy (1945-46), and an instructor in civil and mechanical engineering at Lehigh (1946-53). Mr. Swayne resides in Hockessin, Del., with his wife and three children.

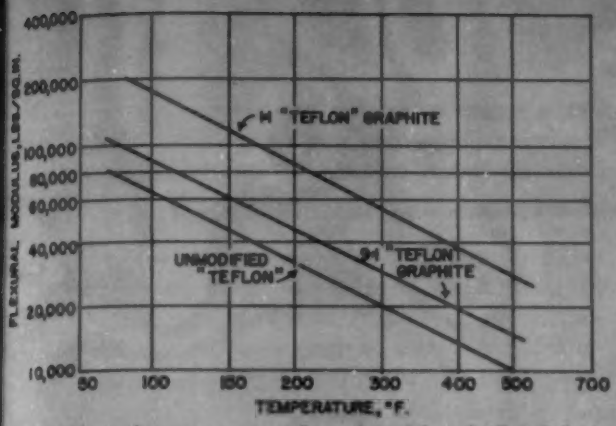


Fig. 1. Effect of temperature on flexural modulus of filled Teflon.

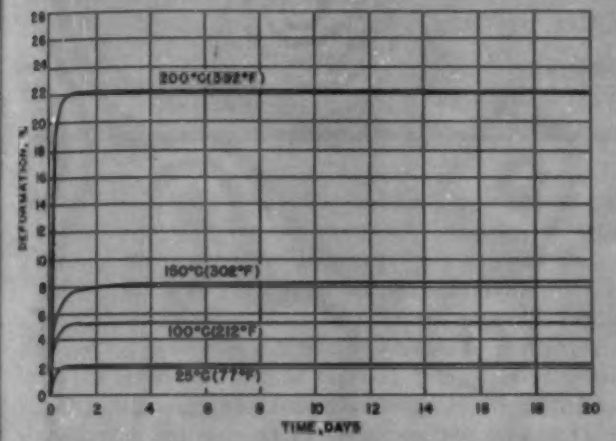


Fig. 2. Effect of long-time compression at 1,000 psi. on heat deformation of solid Teflon.

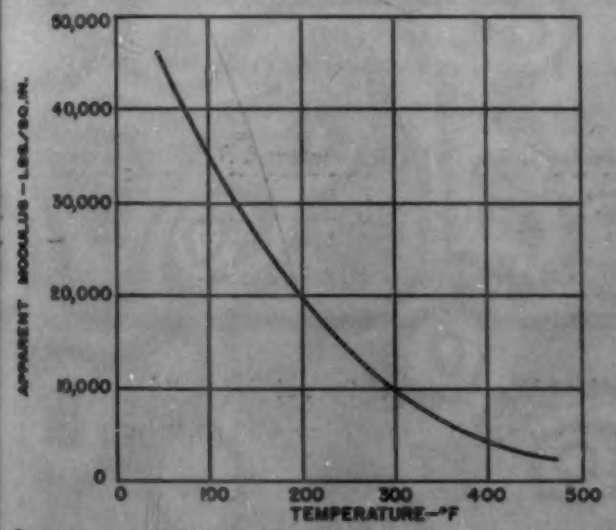


Fig. 3. Creep or cold flow of Teflon, in terms of apparent modulus vs. temperature.

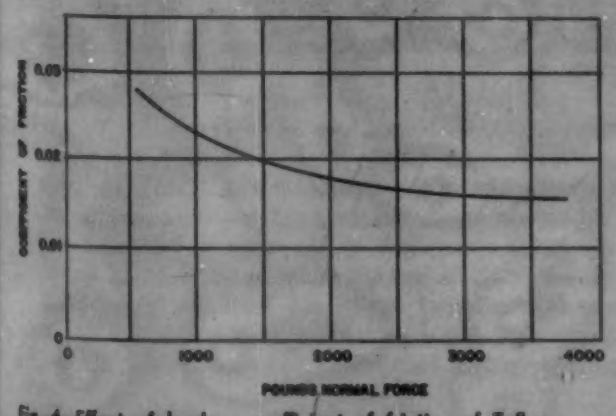


Fig. 4. Effect of load on coefficient of friction of Teflon.

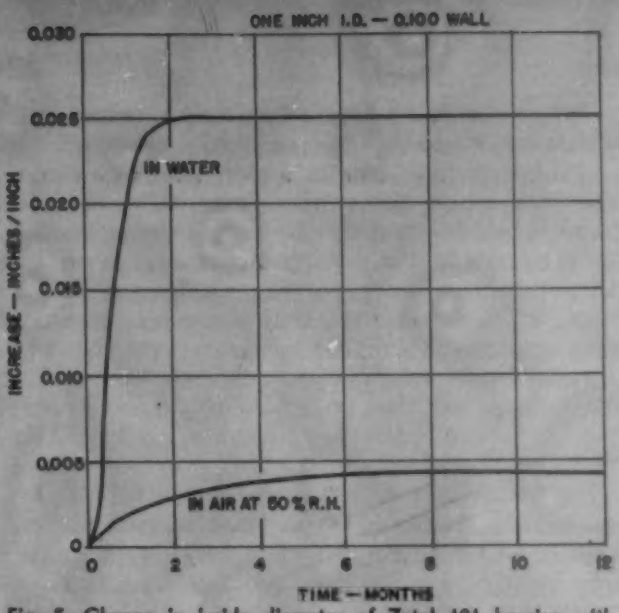


Fig. 5. Change in inside diameter of Zytel 101 bearing with moisture absorption.

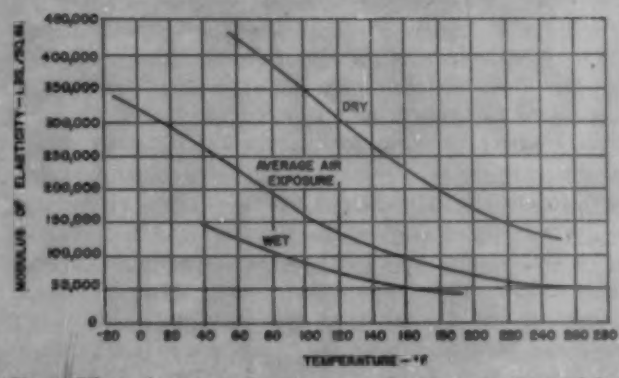


Fig. 6. Effect of exposure temperature and environment on modulus of Zytel 101.

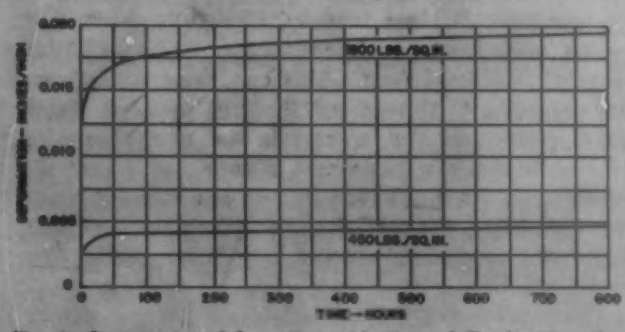


Fig. 7. Compression deformation with time of Zytel 101 under average air exposure.

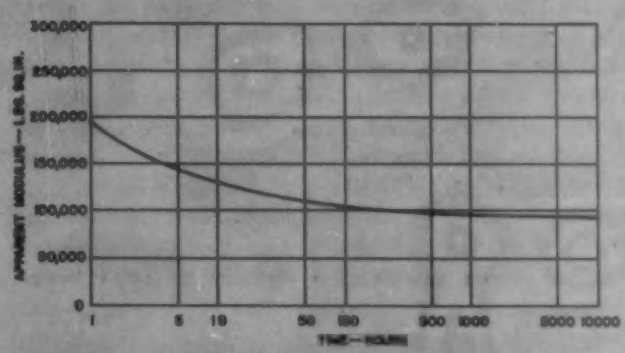


Fig. 8. Creep or cold flow (as apparent modulus) of Zytel 101 under average air exposure.

The deformation produced by a long sustained load is shown in Figure 2. After the initial deformation, the part continues to deform for a short time; then shows little change over long periods. This deformation can be accounted for in design by using a reduced value for the modulus. These reduced values, called an apparent modulus, are plotted against temperature in Figure 3. To calculate the total deformation that will occur after two or more days under load, simply divide the unit stress by the apparent modulus.

Fractional Properties

The low friction of Teflon was first recognized by Shooter and Thomas (1)** in 1949, and was studied further in 1950 by Bowden who stated: "Even in the presence of the best boundary lubricants, metal surfaces rarely give a value of the coefficient of friction as low as the 0.04 of Teflon (2). Work at the Naval Research Laboratory (3) soon confirmed these values. Since this is considerably less than the coefficient for such familiar dry lubricants as molybdenum disulfide and graphite (which have values of about 0.09-0.12), the use of the two additives in Teflon cannot be expected to cause a further reduction in friction under the conditions where the low coefficients are obtained. Both of the early studies were subsequently confirmed by work in our laboratories (4) where a sliding coefficient as low as 0.016 was observed (see Figure 4).

Various effects of the sliding speed upon the coefficient of friction have been reported. Early work at speeds below two feet per minute showed little effect. Recently, however, Milz and Sargent (5) pointed out such a relationship did exist, and added: "There has been a tendency to assign one coefficient of friction value to each plastic and neglect the possibility of significant changes in performance caused by variations in operating conditions." More recently, Flom and Porile (6) have substantiated this dependency on speed and have revealed additional facts which contribute towards an understanding of this subject. They pointed out that a major portion of the increase in the coefficient with rubbing speed is a permanent change and is not reversible; i.e., once a Teflon surface has been subjected to a high speed, the coefficient normally associated with high speed is obtained even at subsequent slow sliding conditions.

The question of why the coefficient of friction changes with sliding speed is difficult to answer. Although several explanations have been suggested, we believe that it has to do with a change in crystallinity of the polymer surface. Thus, it seens very probable that the faster speeds promote crystal growth and that this, in turn, results in a higher coefficient. Such a change would promptly reach a maximum and would be non-reversible. In any case, the effect needs further study. Values obtained by various methods are given in Table 2.

The coefficient of friction of Teflon is essentially constant over a wide range of loads, but does increase somewhat at lower loads. A plot of the coefficients obtained at low speeds as a function of the load is given in Figure 4.

Everyone appears to agree that the coefficient of friction of Teflon is constant with temperature over the range from about 80-620° F. Once the melting point is exceeded, however, the friction doubles. We believe that the high frictional values obtained in some tests are a direct result on surface melting; i.e., surface temperatures above 620° F.

The effect of external lubricants has been studied by several investigators. Data of Milz and Sargent (5) are given in Table 3. As would be expected, water and oil tend to lower the coefficient of friction and extend the useful range of these bearings.

Table 2. Effect of Rubbing Speed on Coefficient of Friction of Teflon.*

Apparatus	Approx. Rubbing Speed, ft./min.	Coefficient of Friction
Sliding hemisphere	0.02	0.04
	0.02	0.04-0.1
Flat ring	Hand turning	0.016
Crossed cylinders	8	0.09
	367	0.21
Rotating cylinder	2	0.05-0.08

* Data from various sources.

Table 3. Effect of Lubricant on Coefficient of Friction of Teflon.*

Lubricant	Teflon-Asbestos, 3:1 By Weight	Teflon-Copper, 1:1 By Weight
None	0.15	0.16
Water	——	0.09
Oil	0.04	0.04

* Data of Milz and Sargent (5). Crossed cylinder apparatus at 5-lb. load and speed of 367 ft/min.

Table 4 Wear Rates of Several Teflon Compositions.

Additive	Wear, *Mg./Hr.
None	0.74
Glass fibers plus pigment	0.0015
Graphite	0.0015
Copper	0.032
Molybdenum disulfide	0.038

* Data by White (7). Bearings ½-inch long by ¼-inch I.D.; Type 303 stainless steel shafts; clearance 0.002-inch at 2,000 psi. and 150 rpm.

Resistance to Wear

All the desirable frictional properties of Teflon would be meaningless if the parts did not also have good resistance to wear. Under relatively light loads and low speeds, unmodified Teflon often is adequate and usually is used. In severe conditions of load and speed, however, reinforced stocks are employed since these have considerable superior resistance to wear. This is shown in Table 4. In addition, work at General Electric

** Numbers in parentheses refer to bibliography at end of article.

(8) proved that the wear rate of combinations of Teflon and glass was 100 times better than that of unfilled Teflon at 250, and a speed of 700 feet per minute.

Any inorganic additives capable of withstanding the temperature required for baking of Teflon can be used for these applications, although the two most common materials are glass fibers and graphite. These additives increase the coefficient of friction more or less in proportion to the amount of material added, but the increase is slight. Extremely low coefficients can be obtained as shown in Table 5.

Table 5. Dynamic Frictional Coefficients

Additive	Weight, %	Coefficient
Very low speed and 1500 psi.:		
None	0	0.016
Molybdenum disulfide	30	0.026
Graphite	30	0.031
Coke Flour	10	0.017
	20	0.023
	30	0.027
At 20 feet/min. and 120 psi.:		
None	0	0.26
Glass fiber	25	0.23
Graphite	40	0.19

Ricklin and Miller (9) did some excellent work on the wear rates of a number of Teflon compositions, and representative data are shown in Table 6. The difficulty with each set of data is that a range of operating conditions was not covered.

Table 6. Comparative Wear of Dry Teflon Bearings.*

Material	Average Wear per Million Revs., In.
Teflon	Could not measure.
Rulon A**	0.00034
Rulon D**	0.0001
Teflon plus	
25% Glass fiber	0.0005
40% Aluminum	Could not measure.
40% Bronze	0.00005
85% Copper	0.001
40% Graphite	0.00077

* Shaft ½-inch dia. of hardened drill rod at 156 rpm. and 120 psi., water-cooled shaft.
** Special Compositions of the Dixon Corp., Bristol, R. I.

It is important that the surface temperatures of the bearing be kept below the melting point, and that only reasonable wear takes place. Some clearance must be maintained under all conditions. We believe that it is desirable to have a surface finish of 16 micro-inches RMS. Little data are available to prove whether even better finishes improve the performance of these bearings.

Load-carrying capacity can be estimated from the PV ratio where P is in psi. and V is in feet/minute. Unmodified Teflon over a wide range of loads and speeds should be used at PV values below 1,000; for filled compositions, the value can be as high as 5,000. Indications are that these values can be higher at low speeds.

Most of the commercial bearings in use today are simple sleeves or thrust washers, although saddle bearings are used in some cases. Ball bearings having alternate balls of Teflon have proved to have unusual properties and are available commercially. The latest development is porous metal bearings impregnated with Teflon. These were developed in England and are now becoming available in this country. No performance data on these bearings have been obtained in our laboratories.

Zytel Nylon Resin

Zytel nylon resin is being used widely in commercial bearing applications. Besides several commercial suppliers of stock bearings, many injection molders produce bearings of given dimensions to order. These vary in size from a 1/16-inch inside diameter clock bearing to an eight-inch bearing used in the valve mechanism of a flour-carrying hopper car. Of particular interest are the bearings or gibs on elevator cars. Gibs made of Zytel have been used for a number of years to run against dry rails, thus eliminating the fire hazard due to the lubricant.

Unless otherwise specified, the bearings discussed here are made from the Zytel 101 nylon resin (the same material previously designated FM-10001). Several other compositions are available that have the general properties of Zytel 101, but have ingredients added for a specific use. Of interest is the heat stabilized composition, FE-2129. This composition, while still retaining an experimental code designation, is commercially available and is more heat resistant than Zytel 101.

Compositions containing graphite, molybdenum disulfide, or other ingredients, are currently on the market, but are not sold by du Pont. In general, however, data on bearing performance are limited so that it is difficult to define the performance to be expected from these various compositions. Certainly, the addition of a material like graphite or molybdenum disulfide with a dry coefficient of friction in the neighborhood of 0.1 could help in dry bearings or prolong the useful life of partially-lubricated bearings if the additives are available at the surface as required.

Because of its importance to the dimensional stability of the bearing, all bearings should be stress-relieved to a temperature at least 50° F. above the maximum expected. This can be done by heat-treating in a suitable oil or other liquid medium. In general, 15 minutes immersion per ⅛-inch of thickness at 300° F. is recommended; the temperature can be raised to 350° F., if desired.

Stress-relieving in hot oil guarantees that strains introduced during manufacture will not be present in the finished part. These strains are objectionable in that the parts normally change dimensions (actually contract somewhat) as the strains are relieved. While manufacturing conditions can be selected that do not develop strains, it often is more practical and a better product

(*Continued on page 230*)

EDWARD C. BROWN, JR., *Sales Service Representative,*
Chemical Division, Plastics Department,
The Goodyear Tire & Rubber Co., Akron, Ohio

Production of Rigid Thermoplastic Sheets

A discussion of materials, equipment, and operations for making sheets by calendering and extrusion.

For many years, camera, meter, and business machine housings, luggage, and many other items have been produced from materials such as metal, wood, and leather. Yet, in recent years this market has been steadily invaded by thermoplastic materials. The increasing importance of thermoplastics in this field is due in large part to their low material and processing costs, durability, and appearance, coupled with better results and service than that from materials previously employed.

Items produced from thermoplastic materials exhibit excellent gloss, stiffness, hardness, and impact resistance. Sheets made from these materials can withstand severe use and still maintain their pleasing appearance. Resistance to most corrosive chemicals is excellent, and processing into finished items is relatively easy.

This article describes how these thermoplastic sheets are produced, and discusses some of the problems and cost factors to consider in the processes.

Materials

There are several polymers which make up the wide variety of available opaque, translucent, or transparent thermoplastic materials. Sheets are made from cellulosics, acrylics, vinyls, ethylene polymers, styrenes, and modified styrenes. Materials are selected for their inherent properties to meet specified application requirements. Table 1 illustrates the wide range of physical properties available among these thermoplastic materials used in the manufacture of sheets.

This discussion is concerned primarily with the modified styrene polymers, because they are among the most promising of the "super-high" impact sheet* materials. Modified styrene resins, such as Goodyear's Plio-Tuf, are a relatively new family of high-impact materials.

* For the purpose of this discussion, sheet is considered as being over 0.015-inch in thickness.

Table 1. Representative Property Data for Thermoplastic Materials

	Specific Gravity	Tensile Strength, psi.	Hardness, Rockwell	Impact-Notched Izod, Ft. Lbs.	Heat Distortion Temp., °F.	Dielectric Strength Volts/Mil
Cellulose acetate	1.24-1.34	4,500-7,500	R95-120	1.0-3.0	130-160	250-300
Cellulose acetate butyrate	1.15-1.22	2,600-6,900	R30-115	0.8-6.3	115-200	250-400
Methyl methacrylate	1.18-1.19	7,000-9,500	M90-100	0.4-0.5	150-210	450-500
Rigid vinyl chloride	1.35-1.55	5,000-9,000	R105-110	0.4-20.0	140-185	700-1,300
Polystyrene	1.04-1.07	5,000-9,000	M65-90	0.25-0.50	160-210	500-700
Modified polystyrene	100-1.10	3,500-6,000	R50-100	0.5-11.0	148-200	300-600
Polyethylene	0.92	1,500-1,800	R11	—	105-121	460

They have excellent chemical resistance, and do not require the addition of plasticizers for the production of sheets. Processing is accomplished on standard equipment such as calenders or extruders. Filters and extenders may be employed to reduce material costs. The addition of elastomers is also permissible to vary the properties of the finished sheets.

Among the important properties of sheets made from these resins are excellent impact strength, even at low temperatures, stiffness, and a high heat distortion point. Typical and electrical properties of Plio-Tuf sheets are given in Table 2. These sheets show good resistance to acids, alkalies, and salts. Aliphatic hydrocarbons may cause slight swelling, while aromatic hydrocarbons and ketones will cause softening and swelling. Resistance to specific chemicals is shown in Table 3.

The physical properties of these sheets are affected only slightly by laboratory exposure. When subjected to extreme and continuous outdoor aging conditions, there will be a noticeable lowering of physical values; however, Taylor and Adams (1)** show that opacifying pigments will reduce deterioration of these properties. In many cases, the slight loss in impact strength and other physical properties experienced under moderate outdoor exposure conditions will not materially affect the use of these materials in a wide variety of products.

In addition to the properties of the sheets already mentioned, press-embossed sheets, such as Bolta Product's Boltaron 7100, show excellent retention of patterns at temperatures well above those required for forming. These sheets are easily formed on conventional equipment.

Table 2. Typical Physical Properties of Plio-Tuf Sheets

Tensile strength, psi		2,300
Elongation, %		50
Hardness, Shore D		70
Impact strength, notched izod, ft. lbs./inch of notch:		
At 77° F.		6 +
At —20° F.		1 +
Impact strength, unnotched izod, ft. lbs./inch:		
At 77° F.		15 +
At —20° F.		10 +
Heat distortion at 66 psi., °F.		195
Stiffness in flexure, psi.		148,000
	1 Kilocycle	1 Megacycle
Volume resistivity	4.1×10^{12}	—
Dielectric constant	1.93	2.69
Dielectric strength, volts/mil	442	—
Power factor	0.0028	0.00286

Table 3. Effect of Chemicals on Plio-Tuf

	After Immersion for 7 Days at 77° F.
Acetic acid	Swelled slightly
Hydrochloric acid	No visible effect
Nitric acid	Discolored (yellow)
Sulfuric acid	Discolored (brown)
Phosphoric acid	No visible effect
Ammonium hydroxide	No visible effect
Sodium hydroxide	No visible effect
Sodium hypochlorite	No visible effect
Salt water	No visible effect
ASTM #1 Oil	No visible effect
ASTM #2 Oil	Swelled slightly
Mineral oil	No visible effect
Process oil	Swelled slightly
Vegetable oil	No visible effect
Petroleum grease	Discolored (yellow)
Glycerine	No visible effect
Ethylene glycol	No visible effect
Ethyl alcohol	No visible effect
Hexane	Softened, swelled, tackified surface
Gasoline	Softened, swelled, tackified surface
Kerosene	Softened, swelled, tackified surface
Toluene	Softened, swelled, tackified surface
Bromo-chloromethane	Softened, swelled, tackified surface
Methyl-ethyl ketone	Softened, swelled, tackified surface
Carbon tetrachloride	Softened, swelled, tackified surface
Paradichlorbenzene	Softened, swelled

Compounding

Compounding of modified styrene resins is relatively simple. In most cases, only pigments, stabilizers, and release agents are added, and the bulk of the compound

**Numbers in parentheses refer to bibliography at end of article.

Table 4. Typical Calendering Formulations

	Formula A	Formula B
Plio-Tuf C75	100	100
Magnesium oxide (extra fine)	2	2
Stearic acid	1	—
Glycerine	—	0.5
Mineral oil	—	1.0
Zinc stearate	—	0.25
Ultramarine blue	3	3.0

consists of the resin. Typical formulations for calendering are given in Table 4.

The magnesium oxide in these formulations acts as both a processing aid and a stabilizer against any discoloration under prolonged mixing. Lubricants aid in release of the sheet from the calender rolls. Materials such as zinc stearate are added in concentrations as high as 0.5-1.0% when slight sticking is encountered. Medium viscosity mineral oil, glycerine, and stearic acid also act as release agents.

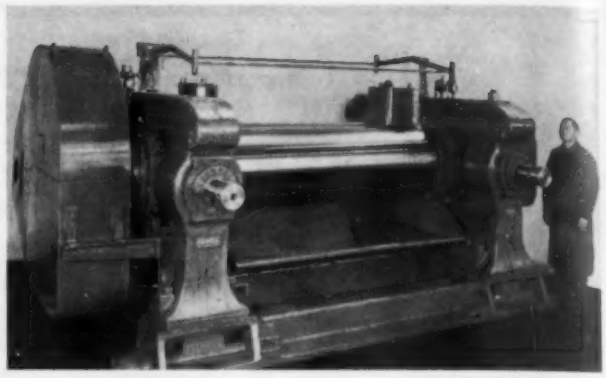
Since the concentration of color pigments in the formulation is low, the pigments must have good dispersion properties. They must also be heat-stable at processing temperatures, and show good resistance to fading and migration. In order to realize full advantages from the compound, the chemical resistance of the pigments must be equal to that of the resin. Representative color pigments are listed in Table 5.

Table 5. Typical Color Pigments for Plio-Tuf

Ultramarine blue
Phthalocyanine blue
Phthalocyanine green
Alizarin green
Watchung red
Helio oil red
Cadmium red
Cadmium lithopone red
Cadmium lithopone yellow
Cadmium yellow
Iron oxide brown

Fillers or loaders are incorporated into compounds to extend the resin, thereby reducing material costs. Typical of these materials are hard clay, calcium and magnesium carbonates and silicates, mica, carbon black, and others. In some cases, these fillers slightly improve processing, but the use of more than five volumes of filler will result in a noticeable decrease in impact strength.

Incorporation of elastomers, such as butadiene-acrylonitrile and butadiene-styrene rubbers, will produce materials with more flexibility, yet still within the rigid classification. Impact strength will increase, while tensile strength will drop slightly. A compound containing more than 30% of added rubber will lean to the flexible classification; at best, however, this line of demarcation is very broad. Synthetic elastomers generally contain sufficient antioxidant to protect the rubber under all but extreme



(Courtesy: Farrel-Birmingham Co., Inc.)

Fig. 1. 26 by 84-inch plastics mill with individual motor drive.

cases of oxidation. In this case, the addition of 1½-2% of an antioxidant, such as Wing-Stay S, will inhibit oxidation of the rubber portion.

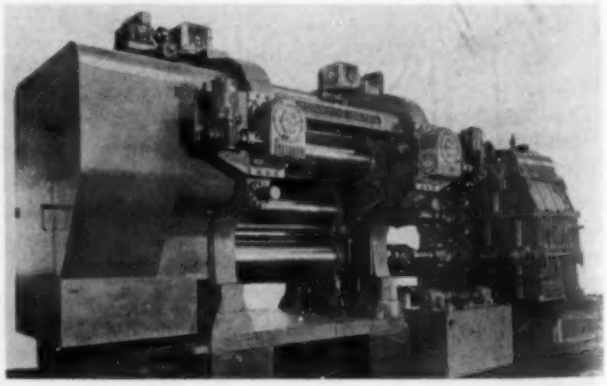
Mixing

With the low concentration of compounding ingredients required for modified styrene resins, thorough dispersion is of paramount importance. Equally important is control of mixing temperatures.

As the initial step in the production of calendered sheet, the resin and other compounding ingredients are fluxed and mixed in an internal mixer. Good results have been obtained when jacket temperatures are near 200° F. If the heat build-up during the mixing cycle is excessive, the batch may become sticky. This can be controlled by raising the ram to prevent further rise in the temperature of the batch.

Mixing time is a function of rotor speed, batch size, and jacket temperature. The cycle must be of sufficient duration to properly flux and mix the compound. Internal mixers generally require a mixing time of about five minutes. When the mixing cycle is too long, the batch is likely to become sticky.

Mill mixing can also be employed (see Figure 1), and multiple units usually are required to insure an adequate supply of stock for the calender. Temperatures of the mill rolls will be about 300° F. Preblending of compound ingredients prior to milling promotes good dispersion and faster mixing cycles. The time required for thorough



(Courtesy: Adamson-United Co.)

Fig. 2. Four-roll, inverted-L, 24 by 68-inch plastics calender.

fluxing and mixing is about 10 minutes per batch. Power consumed in either method of mixing (mill or internal mixer) is not excessive.

Calendering

The latitude of temperatures in calender operations is not as wide for modified styrene resins as that permitted for vinyls. In calendering these resin compounds, the temperatures of the rolls (see Figure 2) are adjusted to gradually cool the stock as it progresses from the top to the bottom roll. This, of course, is opposite to the techniques employed for calendering vinyl sheet.

The compound is fed from the conditioning or feed mills to the calendar in small rolls called "pigs." This method of feeding has been found best for maintaining stock temperature. The calender rolls squeeze the stock to the desired thickness and width. Calender roll temperatures which have given good results are as follows:

Offset roll	320° F.
Top roll	320° F.
Center roll	310° F.
Bottom roll	300° F.

Control of cling and drape may be achieved by adjustment of center roll temperature. The bottom roll must be warm enough to pull the sheet away from the center roll. Sticking on the top roll can often be eliminated or greatly reduced by temperature adjustments of as little as 5-10° F. Sticking will be experienced if temperatures become too high.

As the sheet comes from the calender, it is passed over a series of cooling drums, run out, cut off with a fly shear (in heavy gages), and stacked flat. Sheets of light gage (in the range of 0.015 inch) may be rolled on a wind-up in a continuous piece (see Figure 3). Progress in today's technology permits calendering sheets in gages as high as 0.030 inch. When producing sheets of still heavier gage, small blisters sometimes occur. However, with continuing advances in compounding and calendering techniques, the production sheets in gages of 0.060 inch and over is not unlikely.

Press lamination is employed to produce sheets in all gages, even as thick as ¼ inch or more. Thin sheets from the calender are laid between plates in a press. These plates may have either a smooth surface or an embossed pattern. Heat and pressure are applied for a specified period. As an example, sheets ⅛ inch thick have been laminated at a temperature of 325° F. and a pressure of 250 psi. with a heat cycle of 25 minutes. The temperature of the pressed sheets must be below the softening temprature before removal from the press. The cooling period will normally consume an additional 15-20 minutes. This operation might be likened to an annealing process. Sheets so embossed show excellent retention of patterns during forming and fabricating processes.

Calendered sheets are smooth usually, but may be embossed by passing over an embossing roll as they leave the calender. A pressure roll forces the sheet against the textured roll, and a pattern is picked up on the hot sheet. It is necessary that heat loss of the sheet be kept to a minimum between calender and embossing rolls, and auxiliary heaters are sometimes employed for this purpose. Sheets embossed in this manner, however, do not retain patterns as well at forming temperatures as do press-embossed sheets.

High production rates and continuity of operation in calendering offset the high equipment costs. The output of a calender in some cases will be limited only by mixing capacity and as the sheet gage becomes heavier, the mixing capacity becomes more important. It is estimated that the cost of a calender and necessary auxiliary equipment will be in the range of $750,000 or more. Auxiliary equipment includes internal mixers, mills, take-off rolls, and wind-ups. In addition, presses and embossing plates are required for laminating procedures.

Extrusion

Material for extrusion normally is supplied in the form of pellets already compounded and mixed. Resin preblended with other compound ingredients can be extruded without any mixing other than accomplished in the extruder barrel. However, to realize optimum values in the properties of a modified styrene resin, full mixing procedures are considered advisable.

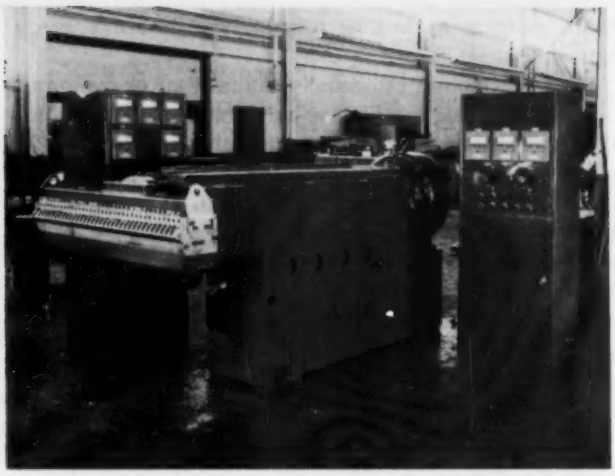
A very important part of the extruder is the screw. There are many types, such as the full-flighted, torpedo, modified torpedo, as well as variations of each type. Each type will give best results for one or more specific materials. A full-flighted screw with a compression ratio in the range of 2:1 gives the stock the desired amount of working, and has proved satisfactory for the extrusion of modified styrene sheets.

In the extrusion process, the screw pushes the stock from the hopper through the heating zones of the barrel where it is plasticized and, thence, through the die. Barrel temperatures will range from 200° F. at the hopper end to as high as 450° F. at the die end. Temperature adjustments are advisable to fit specific equipment and conditions. Typical extrusion equipment is shown in Figure 4.

Material flow within a flat sheeting die is effectively controlled by a temperature gradient across the die. The variation between the center and ends of the die will be in the order of 40-50° F. or more. The resultant differential pressures within the die promote uniformity of flow from the die lips. Die temperatures for the extrusion of

(Courtesy: Plymouth Rubber Co.)

Fig. 3. Plio-Tuf sheet, 0.015-inch thick, that has been rolled on a wind-up.



(Courtesy: National Rubber Machinery Co.)

Fig. 4. NRM 4½-inch Model 50 extruder equipped with 48-inch wide sheeting die. Control cabinet is at right.

Plio-Tuf will be in the range of 390° F. at the center to 430° F. at the ends (2).

As the sheet comes from the die, it passes over take-off rolls which cool it gradually. These rolls should be highly polished to impart a gloss to the sheet. Should an extremely high gloss be desired, clear oriented polystyrene film can be laminated to the extruded sheet as it passes through the take-off rolls. Sheets as thick as ⅛ inch or more have been extruded, but a limiting factor in the extrusion of heavy gages may be the size of the extruder available.

Of considerable interest in the extrusion field is a technique suited to high production runs which combines a continuous process of extruding and forming sheet. As the sheet comes from the extruder, forming temperature is maintained by auxiliary heaters while moving the sheet to the mold area. A travelling mold drops over the sheet and a vacuum is applied, drawing the sheet against the mold. After cooling, the item is released, the mold returns to its original position, and the formed items pass on to the trimming equipment. This operation is illustrated in Figure 5. Extra units on hand will minimize shut-down time during equipment failure.

An extruder requires a minimum of supervision by an operator after extrusion conditions have been set. The equipment costs make feasible the acquisition of several extruders. Cost of equipment required to extrude 48 inch wide sheet, including extruder take-off, die, cooling equipment, and cutter, will be about $50,000. Cost of additional equipment required for continuous extrusion and forming will probably range from $7,000-10,000.

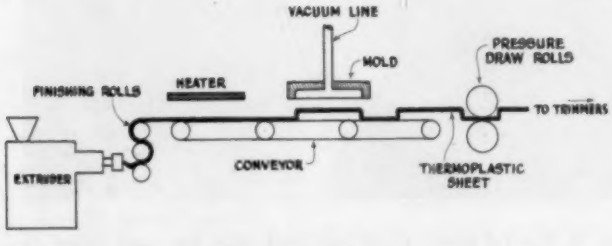


Fig. 5. Diagram of continuous sheet extrusion and vacuum forming.

Conclusion

Rigid sheets can be produced from modified styrene compounds on existing calender or extrusion equipment with, at most, only minor adjustments. End-products then can be formed with conventional equipment and by the usual methods.

These sheets exhibit excellent stiffness, gloss, and hardness coupled with high impact strength. These qualities allow use of the sheets for applications previously adjudged unsuitable. They invite changes in design and fabrication to realize cost reductions in end-products.

Acknowledgments

The author appreciates the valuable assistance of R. J. McCutcheon and other personnel of Goodyear's chemical materials development department and chemical division in the preparation of this paper. The cooperation of Bolta Products also is appreciated.

Bibliography

(1) Taylor, J. R., and Adams, C. H., "Weather Aging of Styrene and Phenolic Plastics," Paper #54-SA-68, American Society of Mechanical Engineers, New York, N.Y. (June 1954).

(2) McCutcheon, R. J. and Fligor, K. K., "Compounding and Processing Copolymer Styrene Resins," PLASTICS TECHNOLOGY, 2, 2, 95 (Feb. 1955).

—THE END

Zytel and Teflon Resins as Bearing Materials—Part I

(Continued from page 225)

Table 7. Dimensional Changes of Zytel 101 Molded Bearings.

Mold Temp., °F.	Inside Diamster, Inches	
	As Molded	Annealed
70	1.024	1.009
100	1.022	1.009
150	1.020	1.010
200	1.011	1.008

obtained, particularly in injection molding, if molding conditions are based on other considerations, and the part then given a heat treatment.

As an example, considerable data have been obtained in the past on the effect of molding conditions on the inside diameter of nominal one-inch diameter bearings. While other conditions have some effect on the apparent inside diameter after molding, the most important appears to be the mold temperature (see Table 7). As can be seen from the last column in this table, the actual change in I. D. size stress-free bearings was considerably less. With higher mold temperatures, even less dimensional change would take place on annealing. While it is possible to vary dimensions slightly by a change in molding conditions, the range of variation is limited. In this case, the molder might select a cold mold and possibly a faster cycle or different temperatures, and then anneal or heat-treat the parts.

(To be concluded in May)

Guest Editorial

Injection Molding Machine Standards

A. J. De Matteo, *Chief Engineer*
Watson-Stillman Press Div.,
Farrell-Birmingham Co., Inc., Roselle, N.J.

The plastics industry has had a growth over the last two decades which is nothing short of fabulous. Contributing to this growth have been many different people, ranging from the scientist in the research laboratories of the great chemical companies to the operator who molds the finished product and in so doing develops new techniques to solve his day-to-day problems. As might be expected, the competitive pressures of rapid growth have forced the industry to fly blind, so to speak.

There has been a dearth of adequate standards or even definitions in almost any field relating to this industry. In the helter-skelter of trying to boost production in order to satisfy demands, we have often lost sight of the right thing or the fair thing to do. Any trivial detail that can be turned to competitive advantage is seized upon and exploited without regard for the well-being of the industry as a whole.

It could be argued that this is a natural corollary of the competitive system. The history of older industries shows what happens. Fifty years ago the steel industry was where we are today. There were no standard specifications and material purchases were made by proprietary names. The growth of the automotive industry fostered the SAE specifications for steel, and ultimately the steel industry adopted standard steel specifications.

A similar pattern of standardization is now under way in plastics. Under the auspices of The Society of the Plastics Industry, standards have been prepared for melamine tableware, vinyl film, and other plastics articles.

Under the same auspices, the injection molding machine manufacturers are working on standards which would promote interchangeability of molds. This group is also attacking some of the fundamental concepts of injection molding machine specifications. Among the features being defined and measured are clamping capacity, plasticizing capacity, and shot capacity. Within a very short period of time, the standardization program will be complete and we will then be able to define and measure these quantities about which we have so long talked.

The program is a splendid example of cooperation from all phases of the industry. While the task has been done primarily by the machine builders themselves, the users group has laid the ground work for what is required. The assistance of one of the larger mold base makers has been invaluable, and the present measuring system for shot and plasticizing capacities has resulted directly from the research efforts of one of the larger chemical companies.

The further advancement and development of injection molding can only arise from the mature consideration of the user's problems and an honest and fair approach to solving them.

—The End

Forming of Rigid Thermoplastic Sheet

An analysis of mold materials, mold design, and methods for post-forming rigid thermoplastic sheets.

ROBERT C. DAVENPORT*, *Vice President and Sales Manager,*

Gregstrom Corp., Cambridge, Mass.

Low cost tooling and equipment are reputed to be the outstanding advantages the sheet former has to offer to the industry. However, an important advantage not often mentioned is the speed and economy with which styling changes may be made in postformed products.

For instance, one large appliance manufacturer has said that from conception of design of a post-formed air conditioner front to production of the first piece, a time lapse of as litle as 30 days may be expected. If the same part were to be injection molded, the time lapse could be 4-6 months.

A unique and important advantage is that minor styling changes desired during the model year can be accomplished in time to realize profits from such changes. This is possible because of mold construction techniques and the materials from which molds are made.

Mold Materials

The commonly used mold materials are plaster, wood, sprayed metal, cast phenolic and aluminum. When runs are small or only prototypes are desired, plaster or wood molds are generally used. For production runs, wood or cast phenolic molds will be more desirable. In high production runs, sprayed metal molds are considered most practicable for thin gage or elastomeric materials. Highest mold life will be realized with cast aluminum or other metal molds.

Generally the first step in the manufacture of a mold is to cast a plaster mold pattern or make a wood die. The plaster used should be one exhibiting low expansion characteristics and high compressive strength. Reinforcement of corners with metal strips aid in strengthen-

* Now vice president and general manager of Sheet Forming Div., Plastic Products Corp., Cleveland, O.

ing the mold, and such reinforcement is desirable when the mold is to be used for short runs. While plaster molds have been used for short sample runs, it is not considered feasible to plan on production quantities from these molds.

Wood Molds

Wood molds are generally made from mahogany because of its tight grain an resultant heat resistance. For fine detail, not practical in wood, brass inserts are employed in the pattern. After the wood die has been made, it can be given several coats of phenolic varnish to close the pores and minimize the tendency of the wood to distort or shrink. These dies may be used in moderate production runs.

Wood molds and dies have been known to have fairly long service life with little deterioration. With proper treatment, a wood die can be expected to give several thousand pieces. The weakness of wood molds is that they tend to splinter and wear, particularly at corners and edges.

Cast Phenolic Molds

Cast phenolic molds are employed for durability and economy. However, selection of a plastic material, such as a phenolic, to merit consideration over metal for a mold should result in a significant advantage such as cost, convenience of construction, or some other factor (1).* Phenolic molds are cast over a wood or plaster pattern with temperature control tubes or coils laid in place during casting. Phenolic mold materials require a curing period during which a combination of room and moderate oven temperatures is usually used to set the mold.

This type of mold is popular because of ease of making, low cost, durability, long life, and good dimensional stability. The equipment required for mold production can usually be found in most post-forming shops. Reinforcement of edges with steel or other metal will increase mold life. A particular advantage of this type of mold is that it may be repaired in the fabricator's plant.

Sprayed Metal Molds

Sprayed metal molds reproduce grains and fine texture in minute detail. The prototype or pattern is first coated with a suitable parting agent. Needles or pins then are inserted at suitable locations on the pattern to provide for vacuum holes in the finished mold. The metal is sprayed to a thickness of $\frac{1}{16}$ inch or more. Temperature control tubes are laid in place, and a reinforcing backing such as epoxy or phenolic resin then is poured. This step is of major importance for mold strength and durability. These molds are suitable for long production runs and fast cycles.

Cast Aluminum Molds

Cast aluminum molds are widely used for large production items. Sand castings may be employed, although better results are obtained from molds which are pressure cast against plaster patterns. Resultant dimensional tolerances and the mold surface uniformity realized with pressure casting require less finishing operations than do other mold making methods. Temperature control coils for controlling the forming operation may be cast in position.

Mold Design

When molds are being constructed, allowance must be made for shrinkage of the mold material, as well as for shrinkage or contraction of the formed sheet. The generous use of fillets strengthens the formed item. In forming heavy gage sheet, generous mold radii are required.

Bridging is a condition in which material over a small area does not conform to the die surface, resulting in a web of material stretching between two components. It is likely to occur when components are located too near each other. Care should be taken when constructing a male mold or die that the spacing between components of a multiple-component die be designed to minimize bridging, or that pushers be employed to isolate components.

Number, size, and location of air evacuation holes also are of paramount importance. If the holes are too large, pimples or bumps may be produced on the surface of the formed item. Holes should be located at each low point of the die contour, as well as at any other points on the mold surface in order that the hot thermoplastic sheet may be drawn tightly against the mold surface. The size and number of holes will also govern the speed of draw. When the amount of air travelling over a certain portion of the sheet is excessive, chilling of the hot sheet may occur, thus preventing proper formation of the item. The speed of draw may be varied on parts of the mold, within reasonable limits, by variations in hole diameter and location, by pattern heating or cooling, and by other techniques.

The removal of excess heat from the mold by circulation within the mold of a liquid at controlled temperature permits high production rates. This is particularly desirable in long production runs where a time savings of even a few seconds on each cycle will make a noticeable difference in production totals.

In general, mold temperatures run from 140-160° F. Temperatures lower than this tend to chill the sheet so that it does not form properly. Since expensive sheet blanks are being used, it is good practice to heat the mold when starting a run to prevent rejection of the initially formed pieces because of chilled molds.

Forming Methods

An additional advantage of sheet forming techniques not often considered is the versatility of methods and the variety of materials available.

From the various sheet materials available certain outstanding characteristics can be obtained, depending upon the requirements of the end-product. Sheet materials available and the prominent characteristic of each are as follows:

*Numbers in parentheses refer to bibliography at end of article.

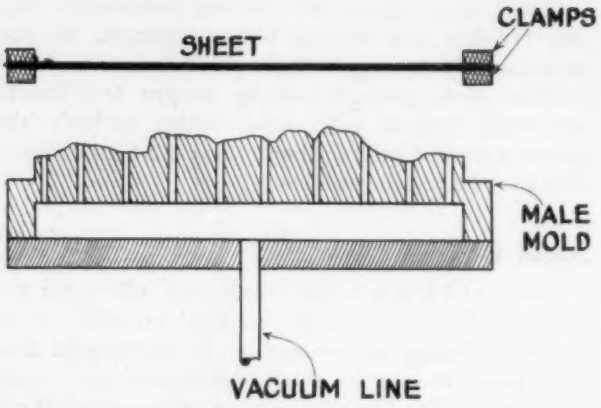


Fig. 1. Diagrammatic view of drape forming.

Styrenes—stiffness, gloss, and hardness.
Modified styrenes—good high impact and low temperature properties, chemical resistance, and stiffness.
Acrylics—good outdoor aging, and good optical properties.
Polyethylene—flexibility coupled with low-temperature impact.
Cellulosics—good hardness and gloss, and fair impact and weathering.
Vinyls—good stiffness, and chemical resistance.

Drape Forming

Among the best known methods of post-forming is the drape forming technique illustrated in Figure 1. Deeper draws can be made by this method than with the vacuum draw, and wall thickness is more uniform. The drape method is preferred when forming preprinted or metallized sheets with the unfinished surface formed against the die, thus minimizing scratching or marring of the prepared surface.

The sheet blank is clamped and heated over the male die. When the stock forming temperature has been reached, the sheet is draped over the male die, being stretched moderately. A vacuum is applied, and the sheet is drawn firmly against the mold surface. When the sheet has cooled sufficiently, the vacuum is released and the item removed. Removal is often eased, as with other methods of forming, if air pressure is introduced through the air exhaust holes, thus blowing the piece from the die. Close tolerances and details can be maintained on the inner or mold surfaces of pieces formed by this method (see Figure 2).

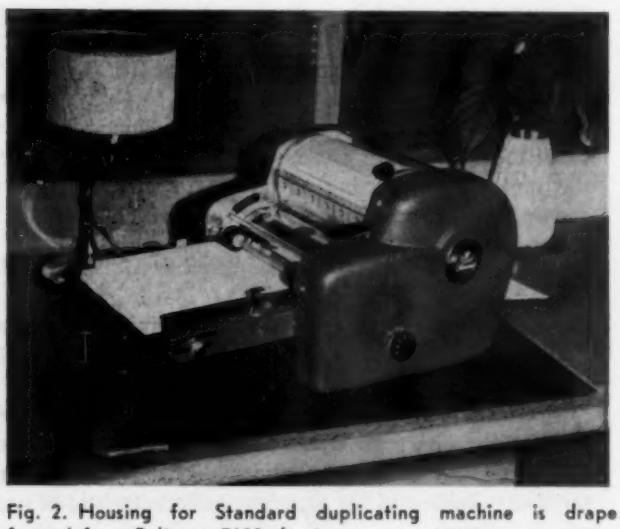


Fig. 2. Housing for Standard duplicating machine is drape formed from Boltaron 7100 sheet.

Vacuum Drawing

Another common method of forming thermoplastic sheet is the vacuum draw. This process is relatively economical and easily accomplished. Female dies are employed with air exhaust holes drilled through the mold. The sheet to be formed is heated to the proper temperature, placed over the die cavity, and held by a frame. The heated sheet is drawn against the mold surface by a vacuum and held until it is cool enough to retain its form. Then, the vacuum is released and the item removed from the mold. Details and tolerances can be best maintained on the outer or mold surface of the formed sheet. This method is shown in Figure 3.

Free Vacuum Forming

A variation of the vacuum draw is the free vacuum forming technique. A vacuum box is required, but a mold is not. The heated sheet is clamped over the box and a vacuum applied. The sheet is drawn to a spherical section of relatively uniform surface strain. The vacuum is released when the sheet has cooled sufficiently to hold the formed shape.

Vacuum Snap-Back

Vacuum snap-back is a modification of the free vacuum forming technique. This method of post-forming, illustrated in Figure 4, involves comparatively low-cost equipment. The sheet is drawn, as with free vacuum forming, to a uniform surface-tension shape. At the same time, a mold or plug enters from the top and rests against the sheet. While the sheet is still hot, the vacuum is released and the hot sheet snaps against the mold or form. A secondary vacuum is sometimes applied to the plug to aid the hot sheet in conforming to depressions in the plug. Finished plugs or molds often are not required.

Plug and Ring Forming

Plug and ring forming, Figure 5, involves a stretch or drape action, and permits deeper draws than with other types of post-forming. After the sheet is heated, it is

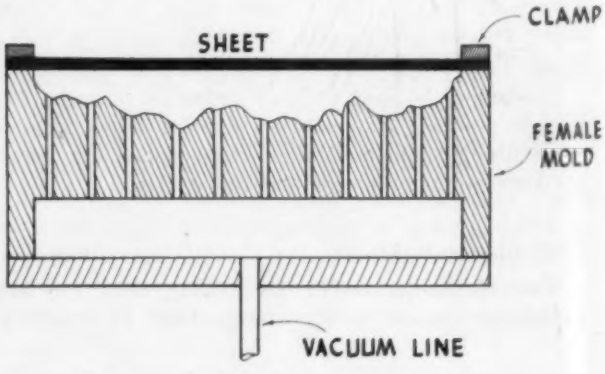


Fig. 3. Diagrammatic view of vacuum draw forming.

clamped over a frame. A plug is forced into the heated sheet, causing it to conform to the plug contours. At this point, some slippage of the sheet material between the clamp and the frame is allowed, thus permitting uniformity in wall thickness. After the plug reaches the end of its travel, a vacuum sometimes is applied to draw the sheet against any depression in the plug surface. A typical application is shown in Figure 6.

Blow Molding

Blow molding is a proceduce employed when heavy sheets are to be formed, or when undercuts are required. Figure 7 shows this type of forming. Since great forming pressures are involved, heavy presses and molds are required. The molds must have finished surfaces, because the sheets will pick up mold surface details. The pressure plate is lowered on the heated sheet to seal against air leakage. Pressure is applied to force the sheet against the mold surface.

Free Blowing

When no mold is employed in blow molding, the method is known as free blowing. This is similar to free vacuum forming, except that air pressure is used in place of a vacuum. Spherical shapes are formed by this method.

Blow and Plug Forming

A variation of the foregoing technique is blow and plug forming (see Figure 8). This is accomplished by locking a blank in a clamp frame before heating it. The softened sheet is placed diagonally over the cavity and clamped in place. Air pressure is applied, blowing the blank into a spherical shape, at which point the mold or plug is introduced and the air pressure gradually reduced. This permits extremely deep draws with relatively uniform wall section.

Line Bending

The simplest method of post-forming is known as line bending. The sheet is heated locally along a line and then bent over a form or jig. This method is employed for straight-line shapes with either sharp or broad bends, and is illustrated in Figure 9.

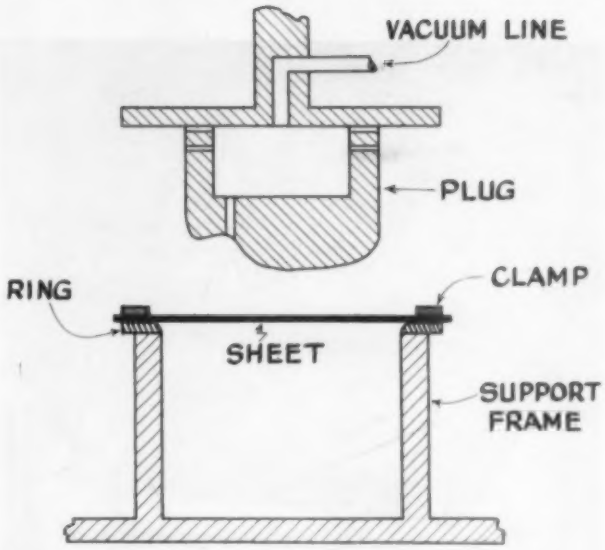


Fig. 5. Diagrammatic view of plug and ring forming.

Fig. 6. Gregstrom tote boxes made by plug and ring forming with vacuum assist.

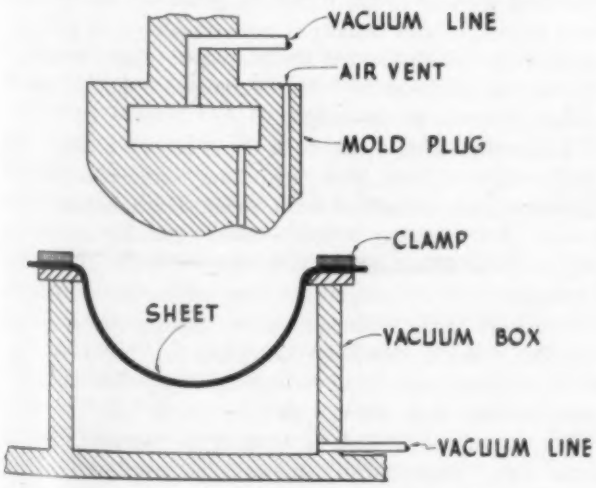


Fig. 4. Diagrammatic view of vacuum snap-back forming.

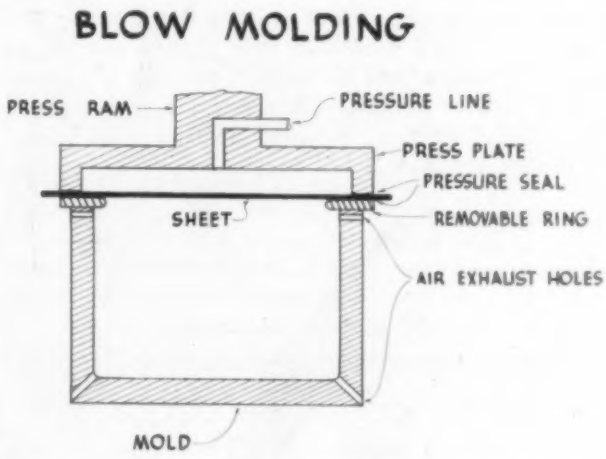


Fig. 7. Diagrammatic view of blow molding method of forming.

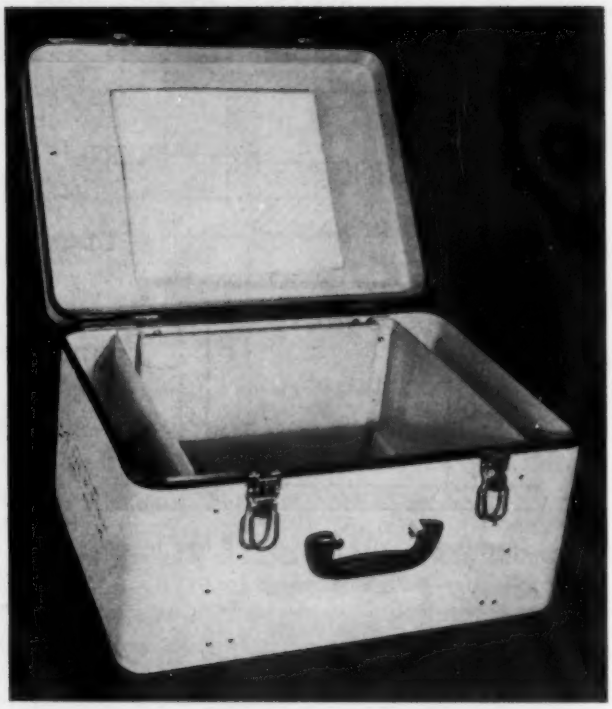


Fig. 8. Case for Navy test kit is made by blow and plug forming of Royalite sheet.

Matched Mold Forming

A method of forming which gives excellent definition and detail, as well as very uniform wall thickness, employs matched molds. The particular disadvantage of this type of forming is high mold costs. Necessary equipment includes presses and steel molds capable of withstanding high pressures. The matched molds cost considerably more than those employed for other methods of forming.

Sheet Heating

Physical properties of formed items are affected by sheet forming temperature as well as by the depth of draw. Drawing at higher temperatures will promote good dimensional stability and low shrinkage (2).

Sheet heating equipment is economical and consists of several types, the simplest of which is a strip heater. Refractors are often used with strip heaters and placed between the heater and the sheet. A refractor is a screen or grid used to uniformly distribute the heat over the entire area of the sheet. Infra-red lamps or panel heaters are used in a manner similar to strip heaters, and tend to give a more even heat distribution than do strip heaters. Several variations of infra-red lamp heaters now are being made which give excellent results.

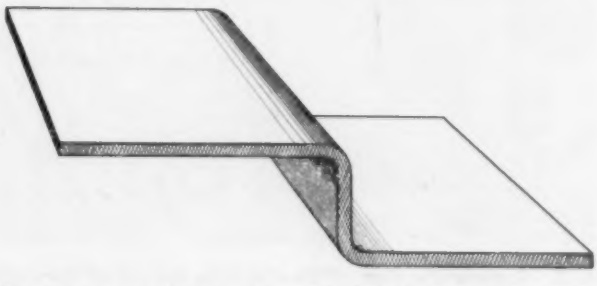


Fig. 9. Drawing of line bending method of sheet forming.

A heater which gives an extremely uniform distribution of heat over the entire sheet surface is one made of glass cloth interwoven in either a linear or grid pattern with nichrome wire. Because of its heating uniformity, this heater often is used when forming sheets of very thin gage.

Temperatures of heating elements may run as high as 1,200° F. Temperatures and cycle time depend upon several factors, one being the placement of the refractor which generally is located 2-3 inches below the heating source. Actual placement of the refractor and the sheet to be heated is best determined by actual trial on plant production equipment. Care must be taken to avoid excessive heating of the sheet, or it may tear during forming. Once the set-up for heater, baffle, and stock has been determined, changes usually are not necessary in subsequent runs.

In some cases, a baffle is employed to keep certain sections of the sheet cool. These baffles generally are wire or metal pieces used to prevent specified sections of the sheet from being heated as much as other sections. In areas of extreme draw, that part of the sheet which is cooler will not thin out excessively, so that a more uniform wall section is obtained. Spot or strip cooling may also be employed as the sheet is being formed. This is generally done by applying a stream of air or other medium to the section which is to be cooled.

Differential heaters employ elements which vary from each other in heating capacity. As a result, heaters can be constructed to vary the heat across a sheet as desired. This type of heating is effective in forming large items with a varying depth of draw, and aids in maintaining a uniform wall section.

Finishing

The function of the fabricator is not finished with the construction of the mold and forming of the piece. A major process, that of finishing the formed piece, then becomes a prime key to successful operation. Trimming costs of post-formed items are important factors. In injection molded items, trimming generally can be held to a minimum and usually is not considered of primary importance. With formed thermoplastic sheet, however, the trimming operation often becomes a major factor in determining the profit margin.

Trimming equipment such as steel rule dies and leather-type cutting dies, including three-dimensional trimmers, are employed with sheet. High impact materials allow shearing action without cracking or breaking, with resultant production speed-up. As trimming operations are of paramount importance to economy, use of high impact sheet to allow rapid punching and riveting without cracking, chipping, or breaking the items is important. Other trimming equipment such as saws, cutters, and shapers may be employed.

For materials difficult to trim or of extremely large area, our "Thermotrim" method is employed. This usually consists of a forged die heated to a temperature

(Continued on page 245)

W. CROFUT, *Staff Consultant (left)*
and
L. B. KELLER, *Technical Staff Member (right)*
Plastics Department, Research Laboratories,
Hughes Aircraft Co.,
Culver City, Calif.

High-Quality Plastics Components for Guided Missile and Airborne Radar Systems*

Uniform and reliable plastic parts can be made only with adequate raw material inspection, accurate process control, and proper part inspection.

High-performance radar-equipped interceptor aircraft and guided missiles are needed by the military for use in tactical operations that continually grow more demanding. Each succeeding design must provide velocity and altitude capabilities that surpass those of preceding designs, and the problems of the designer become more complex with each more stringent requirement.

Outstanding among the problems that arise in developing these high-performance vehicles are those brought about by the scarcity of engineering materials of suitable properties for the aerodynamic heating, aerodynamic loading, accelerations, and vibrations that will be encountered. It is also significant that these vehicles will be required to operate in a wide range of climatic conditions. Design objectives that already exist for missile and radar systems require materials having characteristics that surpass those of materials currently available.

Some evaluation of materials and components under accelerated environmental conditions, especially temperature extremes, can be made in the laboratory. This task has become more difficult lately because more complex and accurate test equipment and more rigorous test procedures are required to simulate the wider range of conditions that must be met. The environmental test procedures currently in use have been patterned generally after those described in military specifications MIL-E-5272 and MIL-E-9400.

Design Considerations

Plastics materials with their high strength-to-weight

*Based on a paper presented at the Golden Anniversary Aeronautic Meeting, Society of Automotive Engineers, Inc., Los Angeles, Calif., Oct. 14, 1955.

ratios and excellent electrical characteristics appear to be well adapted to the airborne electronic field. Plastics are a necessary choice for use in some components, such as radomes; however, for use in many other components in this field, they must compete with metals, glass, ceramics, and other materials.

For most current plastics applications, the plastics engineer is limited to materials that are commercially available, and must develop methods for processing these materials into high-quality components. Unlike the majority of other materials for engineering use, plastics must undergo a radical conversion in the fabrication process. Because of the rapidity of the initial reaction, the conversion appears to be made by purely physical means at elevated temperatures. In reality, however, a complex system of chemical and physical changes takes place throughout the molding cycle, which may last for an extended cure time.

Parts of identical shape and made from the same raw material may range from excellent to worthless (see Figure 1), depending on the care and precision used in the conversion or fabrication stage. Thus, the physical characteristics of a plastics material as determined from standard test specimens are of only limited help in predicting the qualities of a finished component. Plastics are not, per se, a panacea for the problems of the radar and missile builder. It is by governing and controlling this complex system of molding variables that high-quality plastics parts can be made.

Reliability, as demonstrated by consistent, successful performance under the most stringent operating conditions, is probably the most universally desired characteristic in any component, and its attainment is a primary problem. For plastics parts, the most important ingredients of reliability are uniformity of material and reproducibility of process. A successful process, therefore, must incorporate parameters that are accurately controlled within a range sufficiently narrow to produce a part having the required quality, yet are still realistic enough to permit satisfactory duplication in large-scale production.

Another striking problem with which the plastics engineer must cope when designing parts for use in airborne electronic systems is the extreme limitations imposed by weight, space, and shape requirements. Often, so much circuitry and hardware have to be packed into a limited space that the shapes of internal components must be small and irregular. The configurations of exterior plastic parts such as radomes, stabilizers, or missile wings are limited by aerodynamic and electrical considerations (see Figure 2). Because of this, the problem of the plastics engineer is often not the design of the best plastic component, but the means of fabricating the best component in a particular shape and within a strict weight limitation. Actually, the opportunity to design components ideally suited to plastics techniques rarely occurs.

Consistency in the electrical and physical properties of the parts at elevated temperatures is also often a requirement. Radar systems are generally designed to operate under ambient temperatures that range from -70 to $+180°$ F. The temperatures of some internal components may, in operation, rise to as high as 400° F. External components are subjected to aerodynamic heating, an ever-present problem in missiles that will become

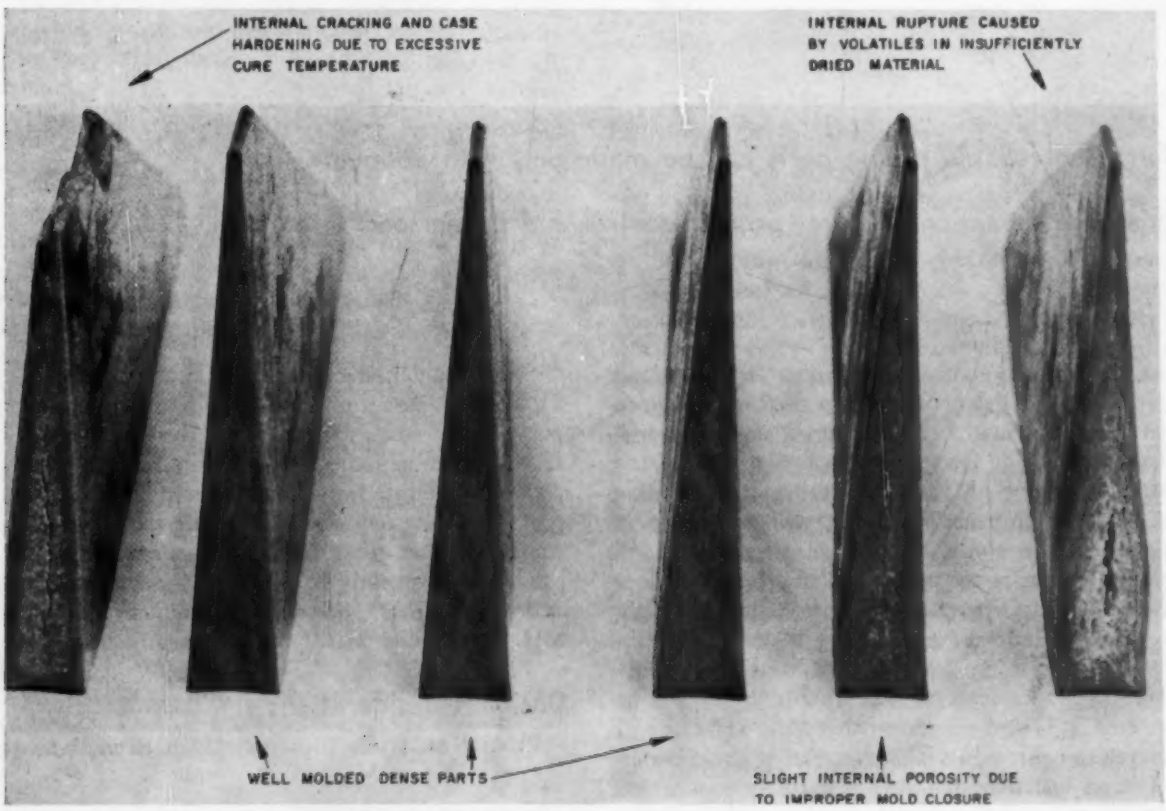

INTERNAL CRACKING AND CASE HARDENING DUE TO EXCESSIVE CURE TEMPERATURE
INTERNAL RUPTURE CAUSED BY VOLATILES IN INSUFFICIENTLY DRIED MATERIAL
WELL MOLDED DENSE PARTS
SLIGHT INTERNAL POROSITY DUE TO IMPROPER MOLD CLOSURE

Fig. 1. Cross-sections of plastic missile wings showing effect of processing conditions on internal structure.

more of a problem in aircraft radome development as the speed of radar-equipped aircraft increases.

It is the purpose of this paper to survey the general applications of plastics materials in missile and airborne radar systems, and to discuss the manner in which problems were resolved by the careful selection of available materials and their conversion, by means of accurately controlled processes, into components that have the required high performance characteristics.

Plastics in Airborne Electronic Components

Plastics materials are commonly used as insulation for internal wiring. Sleeving, braiding, and tying materials usually consist of easily-extruded and film-formed thermoplastics, such as nylon, polyethylene, and various vinyl materials. These materials have been standardized by government specifications so that it usually is not difficult to obtain suitable conductor insulators. However, difficulties are occasionally encountered due to the effects of elevated temperatures in operation, and the near-vacuum conditions that exist at high altitudes. Because of this, the trend has been away from the more flexible, highly plasticized materials and toward pure resin formulations. Recently, Kel-F, Teflon, and silicone rubber coatings have been used a great deal, particularly in high-temperature applications.

The practice of potting or embedding delicate electronic assemblies in plastic materials has come into use as a technique for protecting them from deterioration due to humidity, vibration, and shock (see Figure 3). These potting materials range from highly-filled dense materials to light organic foams. Their characteristics range from very rigid and brittle to flexible and soft. The basic plastic materials currently being used in production are the polyesters, acrylics, epoxies, and silicone rubbers. Isocyanates, alkyds, and silicones are used in foam embedments. Very many variations in resin, copolymers, fillers, and processing techniques are being employed, but one universal factor is evident—that precise control of mixtures and techniques is necessary to the successful production of uniform potted or embedded components.

A large percentage of the plastics materials used in missile and radar systems is in the form of laminated sheet and rod stock. Paper-based phenolic materials (such as types PBE and PBE-P under MIL-P-3115) have been used traditionally in the fabrication of terminal boards and other electrical parts. However, electrical requirements have become more exacting and production quantities have so increased that, for reasons of economy, parts machined from these basic paper-based materials are being replaced by parts molded from a host of special-purpose materials. Laminates of epoxy, melamine, diallyl phthalate, and polyester resins combined with reinforcing fibers of glass, nylon, Orlon, Dacron, and other fibrous materials are being used. The diallyl phthalate and epoxy laminates with organic fiber reinforcement are particularly promising because they are readily machined and retain high d-c resistivity under the most severe humidity cycling.

The application of injection molding to missile and radar parts has been limited to a few materials such as nylon, Kel-F, and, in a few cases, the acrylics and polystyrenes. Most of the thermoplastics have not been used for this purpose because of their low heat-distortion points and the difficulty of maintaining close tolerances in these high-shrinkage materials. Injection-molded parts are used in mechanical applications such as gears, bearings, and special fastenings. Clear acrylic materials are molded into transparent covers for small radar components. Specially-formulated thermoplastic materials have been developed to provide specific electrical qualities, such as low loss and high dielectric constant. Kel-F and Teflon, although the latter cannot be molded by conventional means, are widely used in radar applications due to their high-temperature stability and low loss characteristics.

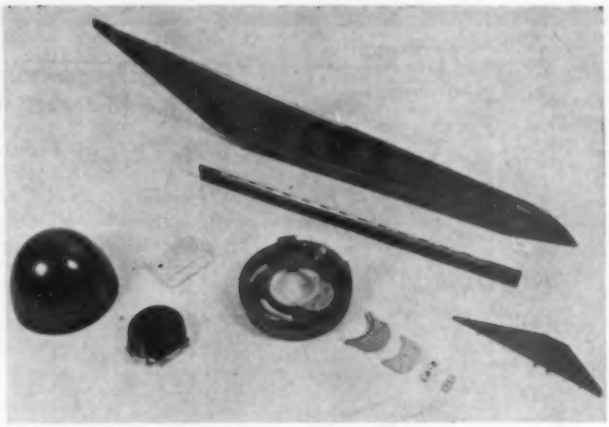


Fig. 2. Typical plastic missile and radar parts.

Thermosetting materials are transfer and compression molded into a wide variety of parts, such as connectors, terminal boards, switches, rotors, and housings. Materials containing cellulosic fillers, while widely used in industry, are unsatisfactory for radar and missile use because of susceptibility to fungus attack. The present trend in missile applications is toward the use of synthetic fiber-filled materials for severe electrical requirements, and of glass fiber-filled materials when strength is the governing requirement. Table 1 gives some significant physical properties of these materials and summarizes their current applications in radar and missile work.

In primary structures and in almost all cases where high strength and rigidity are essential, glass cloth-reinforced laminates have been used. In radar parts, where heat resistance is not a major concern, polyester resin-

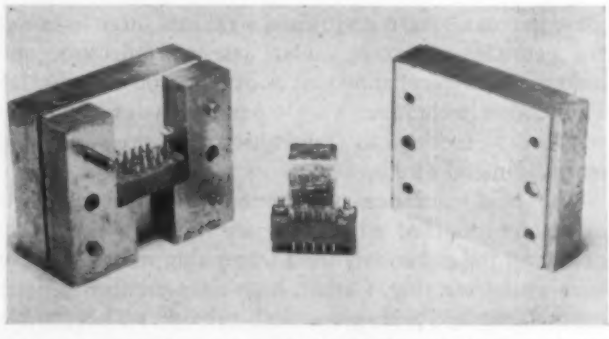


Fig. 3. Open potting mold with Teflon lining, and (center) potted resistor assembly.

Table 1. Properties, Advantages, and Uses of Thermosetting Molding Materials in Guided Missiles and Airborne Radar

	Flexural Strength Psi.	Flexural Modulus, Psi. $\times 10^6$	DC Resistivity, Megohms, 24 Hrs. After Humidity Cycling*	Impact Strength, Izod, Ft. Lbs./Inch Notch	Advantages	Uses
Orlon fiber-filled diallyl phthalate	11,775	0.77	900,000	1.0	Excellent electrical properties even after soldering of molded-in inserts. Good arc resistance. Fungus-resistant.	Terminal boards, switches, rotors, critical electrical parts.
Asbesto-filled diallyl phthalate	8,000	—	80	0.62	—	General-purpose electrical material. Connectors, inserts.
Mineral-filled phenolic	7,900	2.0	1,000	0.28	Low cost.	General-purpose electrical material. Terminal boards, etc.
Glass fiber-filled alkyd	21,500	2.3	130	8-12	Fast curing, high strength.	Less rigorous electrical applications. Structural applications.
Glass fiber-filled phenolic	25,000	2.9	—	8-15	Proper post-curing gives high strength at temperatures up to 500° F.	Structural applications.
Glass fiber-filled diallyl phthalate	9,000	1.25	—	21.0	Fairly high strength; good electrical properties.	Combined electrical and mechanical applications.
Glass fiber-filled polyester	28,000	1.9	—	12-24	High strength.	Structural applications.
Flock-filled phenolic	8,000	—	—	0.55	For comparison purposes only. Not used due to fungus attack.	Standard medium-strength material.
Wood flour-filled phenolic	9,500	—	120	0.28	For comparison purposes only. Not used due to fungus attack.	Standard low-strength phenolic. Subject to fungus attack.
Mineral-filled melamine	8,700-10,800	—	—	0.30-0.41	Excellent arc resistance; good electrical properties.	Switch parts. High-voltage applications.
Nylon flock-filled phenolic	9,500	—	100,000	0.50	Fungus and shock-resistant. Good electrical properties.	Combined mechanical-electrical applications.

*MIL-E-5272 Procedure 1. Material thickness between terminals, 0.100 inch.

glass laminates have performed well, and large housings for cathode ray tubes, radar antenna reflectors, and radomes are typical applications of this versatile material. Fabrication techniques vary from wet hand lay-up on temporary tooling to fabrication in press-mounted matched metal molds.

The heat-resistance requirements for plastics parts externally mounted on missiles are so severe that practically all the commonly-used laminating materials have been found wanting. Certain high-temperature phenolic resins laminated with glass cloth provide an acceptable combination of high strength and rigidity at temperatures up to 500° F. Figure 4 shows the effect of temperature on the flexural strength of various glass-reinforced laminating materials. The values presented are considered typical for carefully made flat laminates, and samples taken from shaped structures usually have lower values. In production, shaped structures made from temperature-resistant phenolics can reasonably be expected to have values of not less than 35,000 psi. flexural strength and 2.5×10^6 psi. modulus of elasticity in flexure at 500° F. To realize these values, however, hardened steel tooling, molding pressures of 400-2,000 psi., and careful material and process control are necessary.

Parts currently being made from temperature-resistant

phenolic laminates include wings, radomes, stabilizer skins, and structural panels. As the speed and flight duration of missiles increases, laminating materials will be needed that retain their strength and dimensional integrity at temperatures considerably greater than 500° F. At present, only the silicones maintain their integrity as laminates when exposed to temperatures as high as 1,000° F. for lengthy periods.

Specific Applications of Materials

The following examples have been selected as typical, and emphasize the effect of processing conditions on the properties of the finished part.

Transfer-Molded Radar Clamp

This part was formerly machined from a solid block of phenolic paper-base laminate, a process which involved 25 separate machining operations. The clamp, which serves as both a mounting bracket and an electrical insulator, contains four threaded holes and two small holes having exceptionally large length-to-diameter ratios.

Table 2. Breaking Loads of Radar Clamps Made from Various Plastic Materials

	Average Breaking Load, Lbs.*
Part machined from paper-base phenolic laminate (type PBE of MIL-P-3115)	900
General-purpose wood flour-filled phenolic molding material	400
Orlon-filled diallyl phthalate molding material	405
Flock-filled phenolic (type CFI-20 of MIL-P-14)	600
Glass fiber-filled alkyd molding material	645
Nylon fiber-filled phenolic molding material	690

*In the test method used, the part was mounted as a clamp and loaded in compression at the location of the clamp-tightening screw.

It was necessary that a molding material be selected that would give the part adequate toughness and some flexibility. Sample clamps were made from several different molding materials and tested for breaking loads, with the results listed in Table 2. Normally, parts made from a glass-filled material can be expected to be stronger than those made from other plastics materials; in this case, however, a thin section in the part did not permit the long glass fibers to orient properly. While none of the molded sample clamps were as strong as the original machined laminate, the nylon-filled phenolic parts were the strongest of those molded and had adequate strength for use in this part.

The conversion was made from a machining to a molding process (see Figure 5), and the mold was designed for use with the nylon-fiber-filled phenolic material. All holes and threads are now molded in, and the only machining operations required are those for the removal of flash and the milling of one slot. Also, since

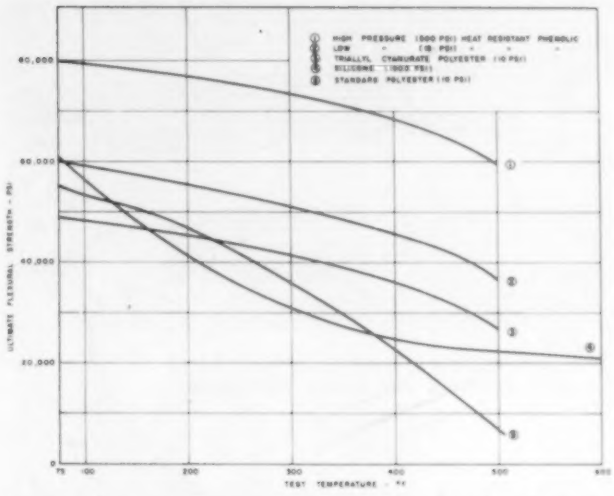


Fig. 4. Effect of temperature on flexural strengths of various plastic laminates.

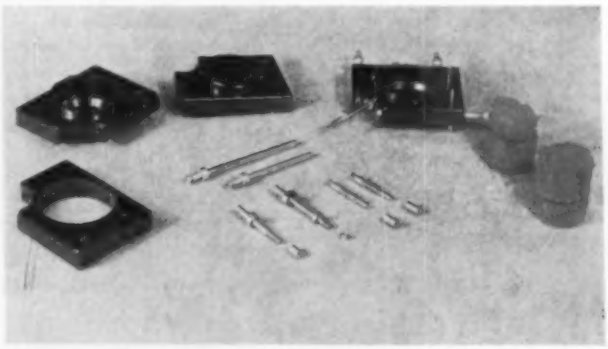


Fig. 5. Molded radar clamp: (right to left) preforms; molded part with inserts; bottom and top views after removal of inserts; and finished part.

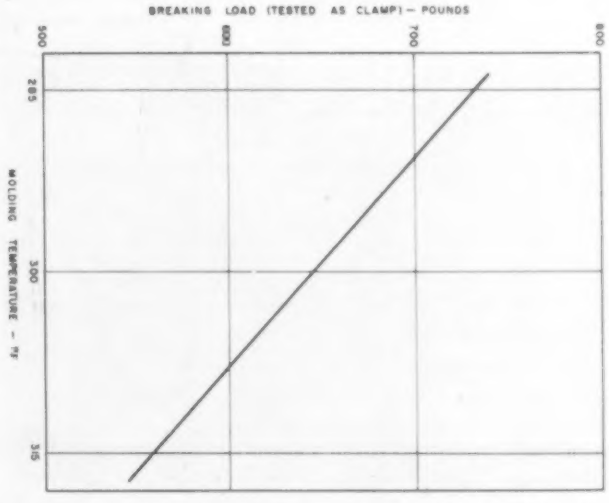


Fig. 6. Effect of molding temperature on breaking load of nylon-filled phenolic relay clamp.

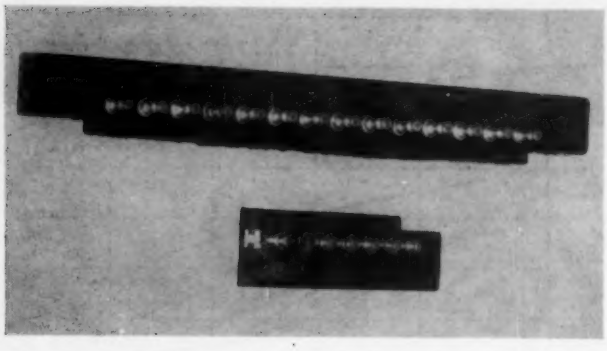


Fig. 7. Compression molded terminal board of mineral-filled phenolic. Sectioned part reveals slight porosity.

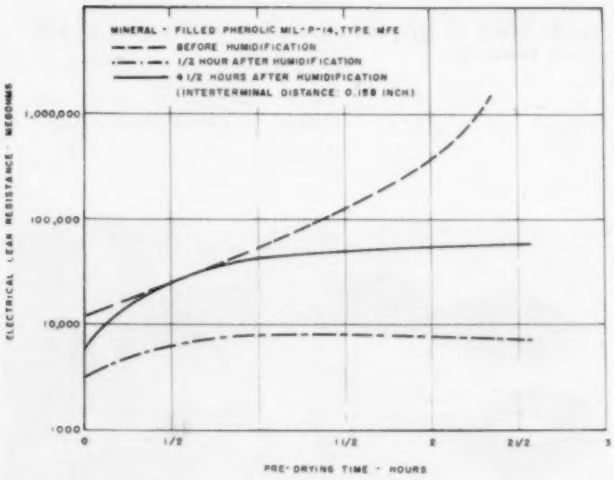


Fig. 8. Effects of process conditions on d-c resistivity of plastic terminal board.

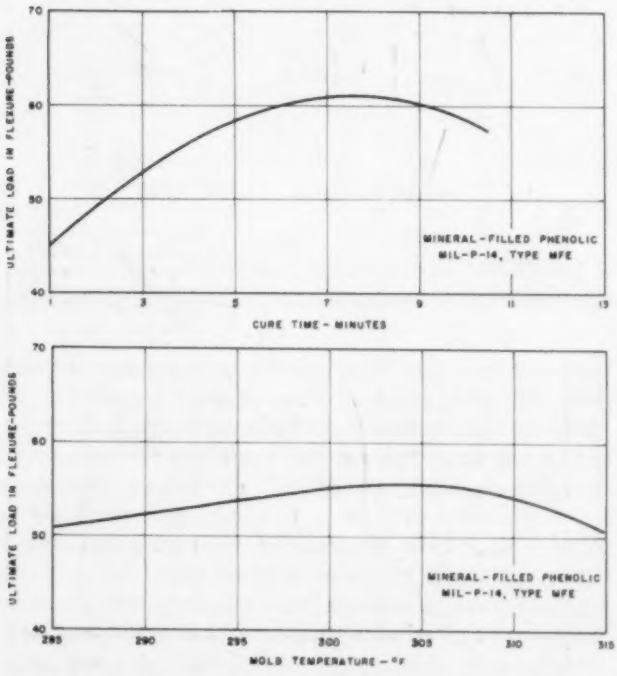


Fig. 9. Effects of cure time and mold temperature on ultimate breaking load of terminal board.

the material of the molded part is fungus-inert, the fungus resisting lacquer treatment formerly applied to the machined parts can now be eliminated.

Molding of the parts under various conditions, each of which was carefully controlled, revealed that the strength of the nylon-phenolic part was reduced by high cure temperatures (see Figure 6). It was also found that extended cure times affected the strength of the clamp. Optimum curing conditions (285° F. for six minutes) were specified for the fabrication of large quantities of the parts, and assured uniformly strong clamps at approximately one-fourth the cost of the machined parts.

Compression-Molded Terminal Board

This part, shown in Figure 7, is typical of innumerable electrical parts used in airborne radar systems. It formerly was machined from paper-base laminates with inserted terminals. Conversion was made to a compression molding using standard mineral-filled phenolic material (MIL-P-14, Type MFE).

From previous experience, this material was considered adequate, but the first molded parts did not retain sufficient d-c resistivity after exposure to humidity. Therefore, an investigation was undertaken to determine the effect of molding conditions on the electrical and physical properties of the terminal boards. It was determined that the d-c resistivity of the part, both before and after humidity cycling (MIL-E-5272, procedure 1), was considerably increased by drying the material at temperatures of 140-160° F. before molding (see Figure 8).

The range of cure temperatures and cure times that should be used to obtain optimum electrical characteristics also was determined. It was found that conditions which increased the d-c resistivity of the part also increased the ultimate breaking load in flexure, and Figure 9 shows the effect of cure temperature and cure time on the strength of the terminal boards. The poor electrical qualities that were found in the first molded parts were eliminated from later parts by specifying that the material be pre-dried, and that a sufficiently long cure within the optimum temperature range be used.

Injection-Molded Core Lock

An insert core lock is another example of conversion from a machining to a molding process. The function of this part is to lock tiny cores in exact position in wire-wound coils. An exact thread was required over the full length of the part, and close tolerances were required on other dimensions.

Attempts were made to machine these parts on automatic screw machines, using a variety of plastic materials. It was very difficult to machine the parts to the required dimensions, and the rejection rate was extremely high. An injection mold was developed that incorporated an automatic unscrewing mechanism to form the fully threaded cavity and to eject the parts. The injection-molded parts were within print tolerances and rejection rates were very low.

Injection-Molded Lens Assembly

The antenna lens assembly shown in Figure 10 consists of a group of injection-molded lens-shaped parts which are made of a specially formulated thermoplastic material and fabricated to close tolerances. A high dielectric constant was obtained in the material by the dispersion of finely-divided titanium dioxide pigment (up to 68% by weight) in a commercial polystyrene material. No major difficulties were encountered in fabricating the parts, but localized burning and charring sometimes occurred in service.

X-rays of finished parts indicated that aggregations of titanium dioxide particles occasionally occurred which were large enough to cause overheating during the passage of high-frequency energy. The titanium dioxide was dispersed in the styrene by grinding the two materials together and then extruding the mixture in a conventional extruder. This procedure, although repeated several times, did not properly disperse the pigment. Investigations were made of other methods of mixing, and a single milling operation on a two-roll mill was found satisfactory. The cost of the material was reduced by use of this milling process, and all parts made from this material were satisfactory.

Fig. 10. Antenna lens assembly made from titanium dioxide-loaded styrene parts.

Low-Pressure Laminated Part

The antenna reflector illustrated in Figure 11 has a parabolic contour and is more than 20 inches in diameter. The dimensional, physical, and electrical requirements for this part are severe. The concave surface of the reflector must conform to the true parabolic surface of revolution within $\pm$ 0.010 inch. In operation, the part is subjected to abrupt changes in humidity and temperature, during which the contour must at no time deviate more than 0.015 inch total from its original shape. The part must also be rigid and must retain its essential shape under severe vibration.

The part incorporates a metallic inner layer that acts as a radar reflector. The metallic layer must be continuous and its resistance must not fall below a given value. All these requirements must be met by a part that is maintained within critical weight limitations. The parts are layed-up from three layers of glass cloth with liquid polyester resin after one layer of glass cloth has been metallic-coated. Molding is accomplished in heated matched metal tooling.

The reflectors, as first made, were acceptable except for a tendency to warp after exposure to humidity. An investigation of the process and testing of parts revealed that acceptable reflectors could be made by using an extended cure in the mold. The investigation also disclosed the extreme care that was necessary in all phases of the process, including preparation of the material, lay-up, cure cycle, and post-molding handling. All this information was compiled in a process specification. In the subsequent production of these parts, the reject rate has been extremely low.

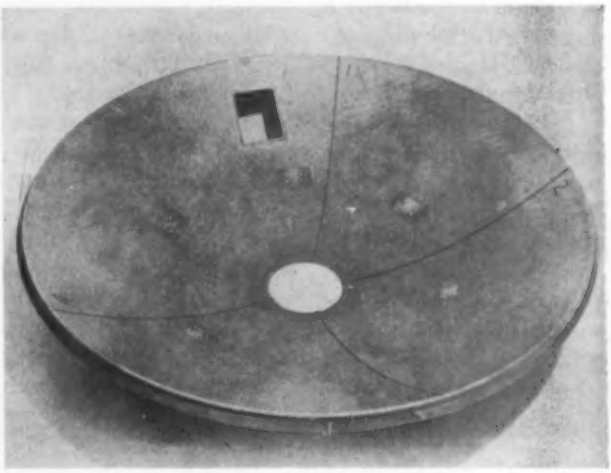


Fig. 11. Antenna reflector made from glass cloth-reinforced polyester resin.

High-Pressure Molded Laminates

A stabilizer glove is subjected in operation to rapid aerodynamic heating to temperatures as high as 500° F. The part must withstand flutter and severe loads in

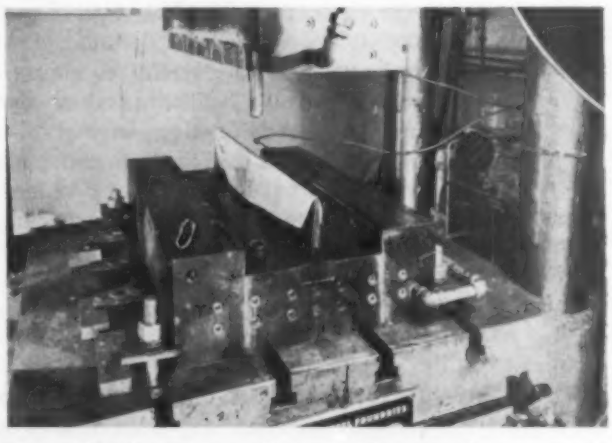


Fig. 12. Stabilizer glove mold showing lay-up preform in position for molding.

Table 3. Dimensional Behavior of Molding Materials Under Various Molding Conditions

	Cure Conditions		Outside Diameter		
	Temp., ° F.	Time, Min.	Average, Inches	Maximum Variation From Average, Inches	Calculated Shrinkage, In./In.
Orlon-filled diallyl phthalate	310	9	5.2126	+0.0007 −0.0004	0.0083
	310	9	5.2172	+0.0005 −0.0007	0.0074
	310	12	5.2193	+0.0006 −0.0005	0.0070
	310	15	5.2214	+0.0006 −0.0007	0.0066
	310	18	5.2218	+0.0002 −0.0005	0.0065
Flock-filled phenolic, type CFI-5	290	4.5	5.2221	+0.0005 −0.0006	0.0065
	290	6.0	5.2266	+0.0011 −0.0011	0.0056
	290	7.5	5.2291	+0.0006 −0.0006	0.0051
	290	9.0	5.2306	+0.0007 −0.0005	0.0048
Glass fiber-filled alkyd	285	4	5.2429	+0.0019 −0.0014	0.0025
	285	2	5.2427	+0.0025 −0.0017	0.0025
	285	1	5.2446	+0.0034 −0.0039	0.0022
Mineral-filled phenolic, type MFE	300	8	5.2388	+0.0002 −0.0003	0.0033
	300	12	5.2392	+0.0002 −0.0010	0.0032
	300	16	5.2399	+0.0001 −0.0005	0.0031

flight at supersonic speeds; must have an aerodynamically clean surface; and the thickness throughout must be held to 0.040 ± 0.003 inch. Some of these parts incorporate a metallic insert. To decrease moisture absorption and, thus, reduce the probability of delamination under rapid heating, an essentially void-free laminate is required.

The material selected was the high-temperature phenolic for which a curve has been given in Figure 4. The pre-impregnated glass cloth used in the manufacture of these parts is controlled by the impregnator to have a narrow range of resin content, volatile content, and greenness (degree of resin advancement, or cure). The cloth is cut into plies and stacked in a preform. The metallic edge attachment is put in place, and the preform is warmed and bent into shape for insertion in the mold. The finished preform may be oven dried at 140-160° F. just prior to molding, if this is necessary to eliminate volatiles and to advance the resin so that it has the correct viscosity in the molding operation.

When ready for molding, the preform is centered on the punch of a hardened steel mold (see Figure 12). The hot mold (300- ± 50 F.) is closed rapidly until the upper cavity just contacts the preform without exerting pressure. This distance is maintained for a precise number of seconds (usually between 15 and 25 seconds) to permit the escape of volatile materials and to preheat the resin to the proper consistency for flow in the mold. The mold is then closed to fixed lands under pressure (2,000 psi. based on projected area). In the final closing of the mold, pinch-offs in the punch and cavity restrict the flow of resin and allow high pressure to be exerted on the lay-up. A small percentage of resin (5-10% by weight) is eliminated from the molding during the molding operation. After curing in the mold for the comparatively short time of 8-12 minutes, the molded part is removed from the punch.

The molded parts are post-cured in a circulating-air oven in which the temperature is slowly raised to approximately 400° F. over a period of several hours. Then, the parts are trimmed, inspected, and bonded

to the stabilizer frame. This process produces uniform parts meeting very rigorous requirements.

Load Bearing Panels

The high-temperature phenolic-glass laminates previously described have such excellent physical characteristics at elevated temperature that they are frequently used as load-bearing panels in stressed-skin constructions. Since the panels are flat, they can be blanked within very fine tolerances from 0.030-0.100 inch thick premolded laminates.

Panels of this type can be produced within tolerances of ± 0.002 inch over dimensions of several inches. Conventional flat-ground punches and dies mounted in standard metal-stamping presses are used. Positive-acting stripper plates are mounted on both punch and die, and the stripper plates are faced with die rubber. These precautions prevent delamination at the cut edge or damage to the laminate by impact.

Maintenance of High Quality

One striking illustration of the effect of variable processing conditions on the characteristics of a part made from a uniform material is that of shrinkage characteristics. Molding shrinkage is defined as the difference between mold dimension at room temperature and the corresponding dimension in the molded part, expressed in inches per inch of dimension. The shrinkage factor for any given thermosetting material usually is expressed as a range, and dimensional tolerances for molded parts usually are less precise than those for machinings. However, shrinkage can be kept within very narrow limits if proper processing control is applied.

In Table 3 are given data derived from a series of controlled compression moldings. The specimens were discs 5-3/16 inches in diameter by 3/8-inch thick that were molded at a pressure of approximately 4,000 psi. Variation in cure time and cure temperature resulted in noticeable variations in diameter. Under controlled conditions, the maximum variation in the 5-3/16-inch diameter within any group of discs was very small, in no case exceeding ±0.0025 inch. Tests made on other parts from different batches of material indicate that such tolerances are realistic, but the control required is expensive.

The high pressures, precise hardened-steel tooling, and short cure times described for the compression molding of the stabilizer glove illustrate a technique which has not yet been widely adopted for the production of reinforced laminate structures. The primary advantage of the high-pressure technique is the uniform high quality obtained.

Conclusions

At the present time, high-quality plastics materials that can meet the requirements of missile and airborne radar systems are available. However, the required methods of raw material inspection, accurate process control, and part inspection have not been developed generally to an extent sufficient to assure uniform and reliable components. A wider application of methods similar to those described above could significantly advance the uniformity and reliability of plastics parts.

New materials will be developed to meet the even more rigorous requirements foreseen for future systems particularly with respect to very high temperatures. To meet the competition other materials will offer, techniques of close inspection and accurate process control will have to be applied to the fabrication of high-quality plastics components. If this is done, plastics can fulfill their inherent promise of adaptability to these applications.

—The End

Forming of Rigid Thermoplastic Sheet
(Continued from page 236)

350-400° F. that with low steady pressure is slowly pushed through the part to be trimmed.

The need for automation in trimming operations is very apparent. A step in this direction is the use of forming equipment employing steel rule-type dies as an integral part of the equipment. During the forming operation, the scrap is trimmed after the air seal is effected. Upon completion of the cycle, the formed and trimmed piece is removed from the mold.

Sheet scrap and trimmings can be a bulky problem unless ground and stored in containers. Granulators or grinders are moderately priced and worthwhile adjuncts to any fabrication shop. Thermoplastic sheet materials often may be reused in the processing of new sheet. Thus, requirements for storage and processing of scrap necessitate that the scrap be kept clean for reprocessing.

To the overall versatility of sheet fabrication, should be added the advantages of distortion printing, painting, vacuum metallizing, lithographing, stamping.

Plastic sheet preprinted in distortion requires a minimum of finishing on the formed and decorated piece. The first step is to paint a formed item and then reheat the piece so that it returns to a flat sheet. Keyline drawings also are employed to obtain fidelity of register. From the master, a silk screen or stencil is made. In large production runs, art work is prepared and photographed from which litho plates are made. Sheets are then printed or painted as a distorted image, and formed when the paint is dry. When the item is formed, the painted sections are in proportion and perspective.

Conclusions

In the final analysis, the most significant features of post-forming thermoplastic sheet are that sheet in styling change is an important advantage; that sheet forming is unusually versatile; that the finishing operations are critical with respect to profit margins; and that other processing techniques before or after forming increase the economic advantages of these processes.

Acknowledgment

Acknowledgment is made to E. C. Brown, of Goodyear Tire & Rubber Co., for his cooperation and assistance with this article.

Bibliography

(1) Brenner, W., and Singer, E., PLASTICS TECHNOLOGY, 1, 1, 20 (Feb. 1955).
(2) Platzer, N., *Modern Plastics*, 32, 144 (Nov. 1954).

—The End

Vinyl Foams Made by

Atmospheric-Pressure Method

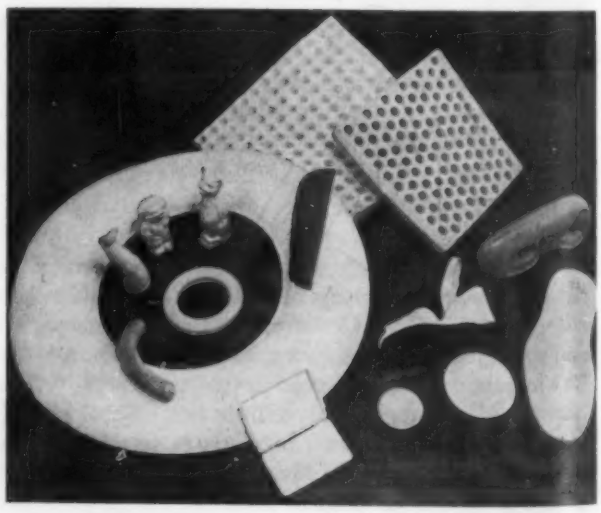
After several years of exhaustive experimental work, Foam King, Inc., New York, N. Y., has successfully developed methods for making both "Open Air Cell" structure (inter-connecting cells) and "Closell" structure (unicellular) foams of polyvinyl chloride at atmospheric pressure. Open Air Cell foams can be made in densities ranging from 5-45 pounds per cubic foot by use of a variety of formulations developed by Foam King. These foams are made chemically, without the use of pressurized molds or high temperatures. The formulations, which can be made to cover practically any desired specifications, are blown and cured atmospherically to give desired foam cell sizes ranging from superfine to extremely large.

Closell foam can be produced in densities up to 45 pounds per cubic foot, in heights up to four inches, and in unlimited widths. The foam can be made as a continuous sheeting or in molds, open or closed, all without added pressure. The finished product has high tensile and tear strengths, unusual uniformity of cell structure, and is claimed to be lower in cost than other unicellular foams because of the simplicity of the manufacturing process developed by the company.

There are two major methods used conventionally for making vinyl foam with inter-connecting cells. One is the mechanical method, such as the Elastomer and Dennis processes, while the other is the chemical method, such as the Foam King process. In the mechanical method, an inert gas, such as carbon dioxide, is whipped into a plastisol while under pressure of approximately 100 psi. and up, and while the plastisol is being agitated and held under controlled refrigerated temperatures. The mixture is then sprayed through a nozzle as a snowy foam which can be subjected to fusing temperatures. The foam made by this method must be used almost immediately, else the gas will escape and cause the foam to collapse.

There are two general methods using chemical blowing agents to make vinyl foam with inter-connecting cells at atmospheric pressures. One method uses a blowing agent, such as Celogen, which does not decompose appreciably until fusion of the vinyl is fairly well advanced. In this process, decomposition of the blowing agent causes the bubbling or foaming of the molten vinyl composition. This method is used only where thin layers of high-density sponge are needed.

The other chemical blowing method is the Foam King process which utilizes a prepared plastisol containing a chemical blowing agent such as Du Pont's BL-353. This plastisol is subjected to temperatures in the vicinity of 212° F. (below the plastisol gelation point), so that the blowing agent decomposes at a moderately rapid rate to form small gas pockets which cause the mass to be foamed. The foam is then subjected to fusion temperatures of approximately 350° F.



Typical vinyl foam products made by Foam King process.

View of Foam King plant showing foam blowing-fusing ovens.

With this method, the time generally required for the blowing stage is from 20-60 minutes, and fluxing or fusion generally requires 20-60 minutes, depending on foam thickness, cell size, density, and formulation. By using dielectric heating, this time can be reduced to minutes. Dielectric heating is needed for foam sections of two inches or more in thickness.

Foams made by the Foam King process are said to be completely free from blow holes. The process does not require pressurized tanks and/or refrigeration; foam density and cell size can be predetermined; and the extent of rise, whether in an open or closed mold, can be predicted. Molded products or slabs made with the process can be stored in either unfluxed or fused form for long periods of time at room, freezing, or elevated temperatures (up to 250° F.) without any visible change. In addition, the unfused mass can take an unusual amount of abuse without collapsing.

The manufacture of unicellular foams generally takes place in pressurized molds (using pressures from 2-10,000 psi.) for periods of 15 minutes or more in order to decompose the blowing agent and fuse the mass. The molds are cooled and the foamed mass emerges into hot water or a heated chamber to complete the expansion by softening the mass so that entrapped gas can expand the foam to its fullest capacity. With this process, foam density ranges of 2½ pounds per cubic foot and up can be obtained.

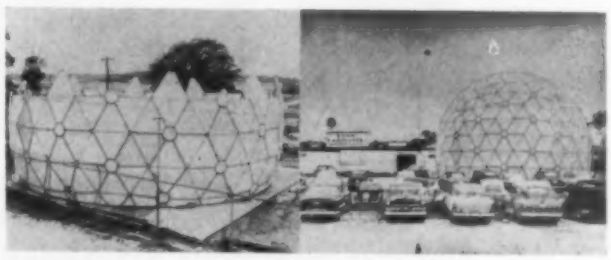
The Foam King process for making unicellular foam does not use pressurized molds or presses, but permits the production of this type of foam at atmospheric pressures on a continuous sheeting bases in unlimited widths and in heights up to four inches. Densities up to 45 pounds per cubic foot can be obtained in a range of cell sizes. The finished foam is said to have much higher tensile and tear strengths, better compression qualities, complete uniformity of cell structure, and low water absorption. In addition, the simplicity of the process reduces the capital investment for equipment, the manufacturing space required, and the cost of the end-product. Semi-rigid, rigid, and flexible unicellular foams made by the Foam King process also have the unique quality of being non-shrinkable, since they are fully expanded before fusion takes place.

Chemical blowing of vinyl foam has been retarded by two handicaps; non-uniformity of resins from batch to batch, and the length of time required for decomposition of the blowing agent. The Foam King process overcomes these handicaps by doctoring the resin batches to achieve uniformity, and the discovery of two new types of resins (under patent applications) which are designed specifically for foaming. In addition, the process includes a method for completing the foaming action (in heights up to four inches) in 10% of the time formerly required. Foams recently developed by the company include both inter-connecting and unicellular types in rigidities approaching that of stone.

Foam King, Inc., recently moved to new facilities which include a complete factory set-up for making end-products, principally to keep abreast of changes or improvements in the manufacturing techniques for foams, as well as to meet demands for its own products. Here, too, the company will manufacture the basic plastisol to meet its own needs, as well as the needs of its licensees. In addition, the facilities will be used to instruct licensees and demonstrate the processes to prospective licensees.

The company is offering its processes on a license basis to other firms throughout the world. Licenses are available for use of the Foam King plastisol and manufacturing processes in making end-products; the manufacture of the basic plastisol; and a combination of both methods.

—The End



Partially-assembled reinforced plastic dome-shelter. (left) Completed dome stands four stories high and measures 55 feet in diameter. (right)

Plastic Geodesic Sphere

A four-story high, 55-foot diameter sphere made up of 363 reinforced plastic parts was recently completed by Lunn Laminates, Inc., Huntington Station, N. Y. Identified as a "Geodesic structure" by its inventor Dr. Buckminster Fuller, Geodesics, Inc., Cambridge, Mass., the clearspan three-quarter sphere was designed to serve essentially as a military shelter.

Reportedly the world's largest rigid plastic structure to date, the sphere's parts are designed in circles and polygons for structural strength. The durability of fibrous glass-reinforced polyester laminates, plus neoprene gasketing throughout, makes the shelter impervious to extreme changes in temperature, and enables it to withstand wind velocities up to 200 mph. The six-ton plastic structure weighs considerably less than conventional domes. Assembly was accomplished by a crew of eight men in a total of 288 hours.

—The End

News of the Societies

Discuss Designing in Plastics

"Designing in Plastics" was the theme of the January 27 dinner meeting of the New York Chapter, Industrial Designers' Institute. Approximately 75 members and guests attended the meeting, which was held at the Fifth Avenue Hotel in New York City.

Monte L. Levin, Monte L. Levin Industrial Design, Inc., discussed "The Influence of Plastics on Product Design," pointing out some of the earlier design applications of plastics, as well as the more recent usages. A portable phonograph in high-impact styrene was shown to illustrate the compactness, possible color combinations, and economy of plastic materials. Another example was an air-conditioner housing, which was light in weight and could be molded in one piece. Plastics open an entirely new field to the designer, according to Mr. Levin, and the applications are virtually limitless.

"Designing with Transparent Plastics" was covered by A. M. Blumenfeld, Rohm & Haas Co., with emphasis on basic design considerations and principles of light refraction. Numerous parts were on display, demonstrating proper and improper use of flat planes, changes in external surface form, dial markings, decoration in shallow relief, paint stops between adjacent color areas, and concealment of attachment devices. Acrylics were the materials under consideration, and the unusual effects obtainable through vacuum metalizing and internally reflecting facets were discussed.

Discuss Plastics Instruments

The February 13 dinner meeting of the SPE Cleveland-Akron Section, held at the Spanish Tavern, Brecksville, O., was the Section's annual "Past Presidents Night," at which certificates of appreciation for their efforts were presented to nine of the Section's past presidents. In a surprise presentation, a wrist watch was given to Frank Martin, Hoover Co., in appreciation for his work as committee chairman of the SPE 1956 annual conference.

In the technical session, Conrad Claeson, Wheelco Instrument Division, Barber-Coleman Co., spoke on "Modern Instrumentation for the Plastics Industry." The various types of instruments used to control temperatures of extruders and injection machines were described, and slides of wiring diagrams for the various types of instruments were shown.

The speaker stated that the proportionating type of pyrometer is replacing the on-off instruments for plastics temperature control problems. Two methods of overcoming the characteristic offset or drag of proportionating controllers were discussed; setting the control point higher than the desired temperature, or relocating the proportionating band with respect to heat input at the control point (normal band location calls for 50% of heat input at the control point).

New officers of the Section for 1956 are as follows: president, H. D. Oliver, Jr., Eastman Chemical Products, Inc.; vice president, A. E. Campi, International Molded Plastics, Inc.; secretary, D. G. Eaton, Reed Prentice Corp.; and treasurer, K. M. Keller, Keller Products, Inc. The three new directors are Mr. Eaton; D. H. Lewis, Packard Electric Div., General Motors Corp., and W. E. Manring, B. F. Goodrich Chemical Co.

Committee chairmen are as follows: professional activities, E. P. Moslo, Moslo Machinery Co.; membership, C. W. Virgin, Spencer Chemical Co.; credentials, J. R. Pecktal, Eastman Chemical; program, J. R. Forsyth, Crucible Steel Co. of America; house, E. J. Haskins, Senith Plastics Co.; educational, G. H. Shirley, Colonial Plastics Mfg. Co.; and Journal reporter, R. M. Hershey, Hoover Co.

Milwaukee Group Meets

A record attendance featured the February 14 meeting of the SPE Milwaukee Section, at which a talk on the molding of phenolic resins was given by R. F. Traflet, Bakelite Co. Amplifying the talk was a showing of the Bakelite film "Molding Phenolics." Following the movie, the group toured the plastics molding operations of the Cutler-Hammer Corp. plant. This tour allowed an inspection of some of the molding operations seen in the film, as well as a display of plastics items being produced in the plant.

Sees New Machine Tool

Some 32 members and guests of the SPE Miami Valley Section were guests of the Sheffield Corp., Dayton, O., on March 1 to witness a demonstration of the company's new ultrasonic machine tool, the Cavitron. According to George Brown, of Sheffield, the machine provides industry with a long-sought means of cutting hard materials quickly, economically, to close dimentional tolerances, and with excellent surface finishes. In addition to this new unit, the attendance also examined displays of the company's wide range of gages, indicators, and precision machine tools.

Jones Discusses "Forticel"

More than 30 members attended t February 27 meeting of the SPE South Section which featured the presentation a paper on "Forticel, Cellulose Propion Molding Compound" by Dave Jon Celanese Corp. of America. Mr. Jon paper had been given originally at the S annual conference in January, and de with the preparation, types, propert processing, and applications of Fortic Three types of this material, differing plasticizer level, are available currently a offer improvements over other cellulo compounds with regard to odor, fabric tion, lacquering, cementing, and surfa finish. Recommended applications for t material include pens and pencils, tel phones, knobs, housings, helmets, and key

New Officers Elected

A special meeting of the board of dire tors and new committee chairmen of th SPE Eastern New England Section wa held on February 14 at Pillar House, New ton, Mass. The new Section officers fo 1956 are: president, Ralph L. Mondan Raytheon Mfg. Co.; vice president, Fred erick P. Quarterone, Bolta Products; sec retary, Josiah D. Crosby, Hood Rubbe Co.; and treasurer, David W. Towler, M W. Kellogg Co. In addition to these officers the other directors of the Section include A. G. H. Dietz, M.I.T.; G. P. Kovach Foster-Grant Co.; W. C. Nissen, Jr. Bakelite Co.; R. M. Smith, Bolta Products and R. S. Ward, Improved Machinery Co R. W. Beckwith, Dow Chemical Co., con tinues as the group's national director.

Committee chairmen are as follows membership, J. P. Clancy, Emery Industries Inc., and Mr. Ward; credentials, Mr. Quar terone; nominating, F. Langhorst, Stanley Chemical Co.; finance and auditing, W. L. Root, Jr., Raytheon Mfg. Co.; program G. P. Fong, Raytheon Mfg.; house, Mr Nissen; publicity, A. I. Simon, Raytheon Mfg. Co.; educational, R. W. Ehlers, Lowell Technological; and professional activities, W. W. Peacock, Jr., National Research Corp.

AIEE Elastomers Conference

A conference on electrical engineering problems in the rubber and plastics industries will be held at the Mayflower Hotel, Akron, O., April 9 and 10, under the sponsorship of the subcommittee on rubber and plastics of the American Institute of Electrical Engineers, New York, N. Y.

Speakers at the two sessions will include W. E. Chope, Industrial Nucleonics Corp.; P. G. Hanna, Westinghouse Electric Corp.; Gregory DeCaudo, The Goodyear Tire & Rubber Co.; W. S. Wolfe, Goodyear; E. L. Smith, The Firestone Tire & Rubber Co.; J. L. Kuelhthau, Allis-Chalmers; Henry E. Mazanek, General Electric Co.; Henry L. Lee, Epoxylite Corp.; W. P. Curtis, Ford Motor Co.; A. G. Seifried, B. F. Goodrich Co.; and W. H. Hickoc, Girdler Corp.

THE MARK OF QUALITY

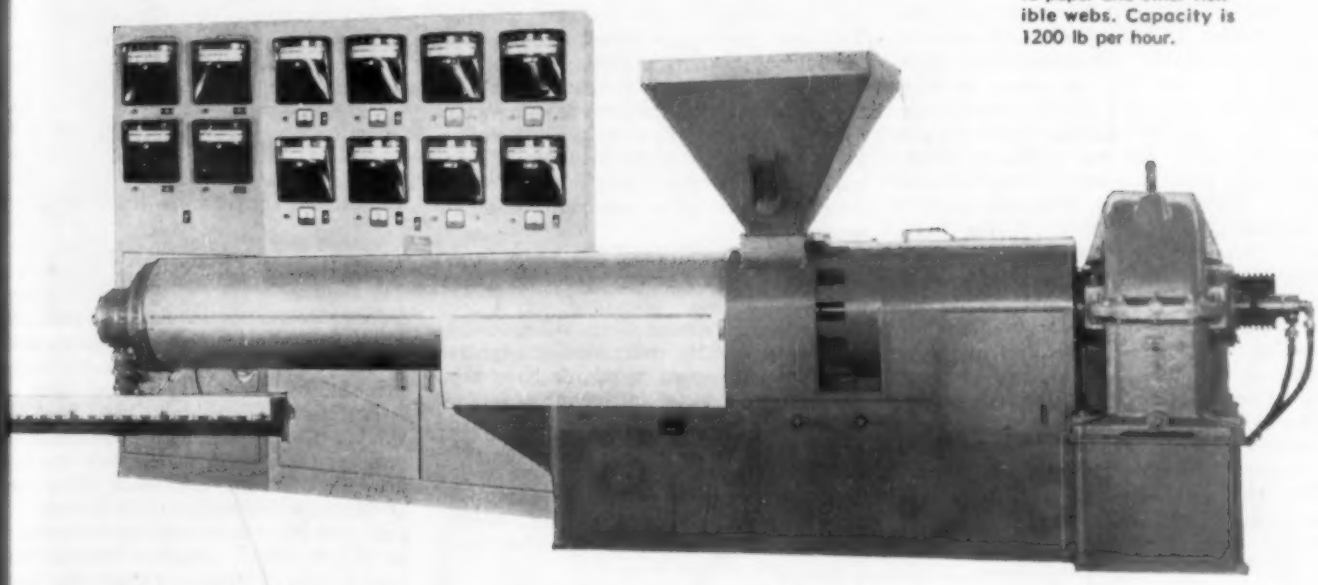
BARBER COLMAN

Wheelco Instruments

"Closest Possible Temperature Control"—Wheelco, of course!

MORE THAN 90% of plastic moulders in the New England Area use Wheelco Instruments, according to official sales records. Wherever plastics machines are used, Wheelco is preferred!

This Egan 8 in. extruder laminates polyethylene to paper and other flexible webs. Capacity is 1200 lb per hour.



"Closest temperature control possible," was the performance requirement specified by engineers of Frank W. Egan & Co. in selecting control instruments for their 8 in. Extruder. Control of maximum precision and dependability is required to maintain tolerances in gauge control in the lamination of polyethylene. Four Wheelco Model 402 Tru-Line time proportioning capacitrols control the temperature of the four zones of heater bands on the extrusion cylinder. Eight Wheelco Model 407 proportioning stepless controllers are used to control one zone of heat on the adapter and seven zones on the die.

Model 400 Series Capacitrols are completely self-contained, direct deflection-type, indicating controllers. They are adapted easily to control requirements of injection molding and extruding machines, as well as plastic packaging and forming machines. Send for Bulletin F-6485 titled "Capacitrols for the Plastic Industry," today!

WHEELCO INSTRUMENTS DIVISION

Barber-Colman Company

Dept. D, 1565 Rock Street, Rockford, Illinois

BARBER-COLMAN COMPANY OF CANADA, LTD.,
Dept. D, Toronto and Montreal, Canada

The two-day meeting will include prepared and open discussions and a banquet. Additional information may be obtained from R. S. Gardner, assistant secretary, American Institute of Electrical Engineers, 33 W. 39 St., New York 18, N. Y.

Injection Molding Discussed

Approximately 65 members and guests of the SPE Cleveland-Akron Section attended a regular dinner meeting on March 12 at the Spanish Tavern, Brecksville, O. The meeting began with the showing of a color film on injection molding operations at the Rochester N. Y., plant of Eastman Kodak Co. which stressed the safety precautions which may be employed. The film showed a possible arrangement of injection molding operations that eliminates the need for operators to ever place their hands between the press platens, uses tongs to removed molded parts from the press, and uses elaborate safety devices to prevent access to the cylinder heaters while the press is in operation.

Following the film, N. C. Taylor, Eastman Chemical Products, Inc., spoke on "Tooling for Thermoplastic Molding." In his talk, he recommended the use of very hot nozzle mold construction for molding cellulosics, acrylics, and polyethylene. In this construction, a long heated nozzle is brought as closely as possible to the mold. The sprue length is shortened, and the material is delivered to the mold in as hot a condition as possible. The speaker noted that, in several cases, this construction has been substituted successfully for hot runner molds in molding cellulosic materials.

Full-round runners were recommended for cellulosics and polyethylene, while trapezoidal runners in one-half the mold were said to be almost as satisfactory. Mr. Taylor recommended that runner length be no more than ⅛-inch, even for molds as large as 16 cavities. Large runners are not needed for cellulosics or polyethylene, and the short runners result in less scrap, fewer welds, and shorter cycles. A land length of 0.030-inch beveled in two directions was said to permit the use of gates as small as 0.016-0.022 inch in diameter for many parts.

The speaker also emphasized the importance of an obstruction within 3/16-inch of the cavity in preventing cold flow lines. If no obstruction is present, the molding material will jet across the cavity and cool off quickly, forming cold flow lines in the finished piece. Mr. Taylor illustrated his talk by displaying typical molded parts and commenting on the molding techniques used for these items.

Two Speakers at Newark

Some 120 members and guests of the SPE Newark Section attended the group's regular dinner meeting on March 14 at the Military Park Hotel. In a brief business session following the dinner, plans were discussed for the Section's annual field day on June 7 at Mazdabrook.

The technical program began with a showing of the General Electric Co. film on extrusion and automatic vacuum forming, dealing with production of refrigerator door liners at the company's major appliance division plant at Louisville, Ky. The film was introduced and discussed by D. A. Davis, of G-E, who noted that the firm has developed a multiple machine to make 100 liners per hour with a minimum amount of operator time.

As shown in the film, the process starts with the extrusion of a 0.093-inch thick sheet of high-impact styrene, and the extruded sheet is immediately laminated to a one-mil sheet of clear polystyrene (taken from a roll of film). This laminated sheet is cut automatically by a traveling shear, and stacked automatically for delivery to the automatic vacuum forming machine. This unit has four positions; the first being the loading point, the second is the heating station, the third position is exposed and is where the vacuum forming takes place, and the fourth is the cooling station. In the interval between loadings, the operator cuts off the edges of the formed sheet by means of an automatic stamping machine.

Following the film and talk was a report on the SPI committee on standards for injection machines, presented by F. G. Deagle, Reed-Prentice Corp. After reviewing the work of the committee, the speaker stated that proposed standards have been prepared to achieve interchangeability of molds from one machine to another, and to measure machine performance. The mold standards include recommended stripper patterns for knock-out pins, and a recommended grid pattern for bolting which is designed to accommodate both T-slots and tapped holes.

Mr. Deagle also described the standards for nozzle radius and locating rings, and noted that the performance standards include clamping capacity, shot capacity, and plasticizing capacity. Shot and plasticizing capacities are measured by use of a standard Dow polystyrene, a Dow thermocouple nozzle, and a standard stock temperature of 420±10° F. While acceptance and practical use of these standards are still in the future, the speaker urged everyone to aid in this standardization program by expressing their comments.

The meeting closed with the distribution of door prizes donated by Gering Products, Inc.; Orangeburg Mfg. Co.; and Plastic Horizons.

Impact Styrene Discussed

A talk on "The Extrusion and Vacuum Forming Techniques of High Impact Styrene" given by W. E. Welsh, Monsanto Chemical Co., highlighted the March 19 dinner meeting of the SPE Southern Section. Some 35 members and guests attended the meeting which was held in Mammy's Shanty, Atlanta, Ga.

Mr. Welsh pointed out that between 20-30 million pounds of polystyrene were processed in 1955 by the vacuum forming technique; a total that is challenging injection molding in industrial significance. Of this total for last year, about 50% was used by the major appliance manufacturers in such applications as refrigerator and freezer door liners.

By means of slides, the speaker discussed various details in the extrusion of high-impact styrene sheet, and the three major methods of coupling the forming and extrusion operations. These techniques were graphically described as in-line extrusion forming, the Ferris Wheel, and the Merry-Go-Round, and all are adaptable to either straight vacuum forming, drape forming, and vacuum forming with plug assist. It was noted that some manufacturers have been able to achieve a 70-second forming cycle; a point of major significance to any large-volume producer.

The talk was followed by a showing of Monsanto's color film "The World that Nature Forgot." This film deals with the role of polymeric chemistry and the plastics industry in our way of life, both now and in the future.

Discuss Plastics in Building

A talk on "Plastics in Building" by A. G. H. Dietz, M.I.T., featured the February 21 meeting of the Elastomer & Plastics Group, Northeastern Section, ACS. Approximately 70 members and guests of the Group attended the meeting which was preceded by a cocktail hour and dinner.

Professor Dietz' talk was based on similar talks he has given elsewhere in the past, and on his article which was published in our June 1955 issue. Using slides to illustrate his remarks, he described recent and potential applications of plastics in the building industry. Non-structural uses as well as structural applications were described, as were recent developments in bonding and protective coatings, inflated structures, light-transmitting walls, and flexible tubing in heated-slab home heating installations. The various plastic materials and their properties were examined, and emphasis given to the physical problems which must be overcome in the utilization of plastics in building.

Evaluating Reinforced Parts

Some 38 members and guests of the SPE Toledo Section attended the March 21 dinner meeting, held at Angelo's Spaghetti House, and heard Paul Fina, Fiberite Corp., speak on "Practical Evaluation of Reinforced Thermosetting Plastics."

The speaker emphasized the importance of correct selection of reinforced compounds for specific applications, since the proper material can result in reductions in part weight and machining costs. Since no one compound is suitable for all applications, the types of resin and filler must be considered carefully and chosen for optimum end results.

NEWS of the INDUSTRY

The winning entries in Koppers' 1956 Design Competition for plastic housewares.

Koppers Design Awards

In a dinner at the William Penn Hotel March 14, Koppers Co., Inc., Pittsburgh, ., presented awards to the winners in e 1956 Design Competition for molders plastic housewares. Sponsored by Kopers, the contest attracted 214 entries subitted by 72 molders. The annual competion is designed to lend active, tangible pport to a program for promoting corct design and proper application of plasics in consumer products. Top prizes are ur one-year and one two-year full-tuition holarships awarded in the winning comanies' names to schools of the winners' oice. The one-year scholarship is the rst prize in each of the contest's four assifications, while the two-year scholarip goes to the "Best of Competition."

The first-prize winners and their entries ere as follows: Class I (polystyrene prodcts for use with food) — Federal Tool orp., Chicago, Ill., for a two-color, four-iece canister set made of impact styrene; lass II (polyethylene products for use with ood)—C. B. Cotton & Co., Inc., Brooklyn, . Y., for a two-color regular polyethylene -Z grip decanter; Class III (decorative roducts of either polystyrene or polythylene)—Bu-Gay Plastic Products, Inc., hicago, Ill., for a self-watering, two-part lanter made of regular polystyrene; and lass IV (home maintenance products of ither polystyrene or polyethylene)—Coumbus Plastic Products, Inc., Columbus, ., for its Lustro-Ware step-on can whose utside is made of impact styrene in two olors, and whose inner can or liner is ade of regular white polyethylene. Columbus Plastic also was awarded the "Best of Competition." The schools receiving the scholarships were Illinois Institute of Technology, School of the Art Institute of Chicago, I.I.T., Cleveland Institute of Art, and University of Cincinnati, respectively.

Honorable Mention plaques in the four classifications were awarded to the following: I, William E. Clements Design Associates, Inc., Cincinnati, O. (for a Brass Rail Portable Bar); II, Plastray Corp., Detroit, Mich. (for a two-tone salt and pepper shaker set); III, Quality Molding Co., Chicago, Ill. (for a two-color watering pot); and IV, Plas-Tex Corp., Los Angeles, Calif. (for a pouring pail with lid). The nine winning entries are shown in the accompanying photograph.

Pittsburgh Merges Divisions

Consolidation of its coal chemicals and plasticizers divisions into a new industrial chemicals division has been announced by Pittsburgh Coke & Chemical Co., Pittsburgh, Pa. The new division will also include an expanded product development section, which will handle both research and promotion. Management of the industrial chemicals division includes Henry Avery, general manager; Duncan J. MacLennan, assistant general manager; John L. Frothingham, sales manager; Afred J. Oxenham, product development leader; and Homer W. Fry, superintendent of production.

Movable Irrigation Pipe Cited

Flex-Flume, a flexible vinyl tubing extruded by Texas Plastic Development Corp., Houston, Tex., was recently commended at two major agricultural meetings for its vital contribution at the irrigation farmer. Of particular value to the small operator, the tubing can be collapsed and rolled, thus presenting no storage problem. Expensive, permanent installations thus become unnecessary.

Flex-Flume reportedly carries large volumes of water at minimum pressures, is inexpensive, and requires no protective coatings or maintenance. Simple, non-leak couplings are used to join standard 100-foot lengths of tubing. In addition to domestic consumption, foreign demands for a low-cost irrigation tubing have reportedly necessitated Texas Plastic's setting-up of an export division.

ALL EYES... You'll be this way at the NATIONAL PLASTICS EXPOSITION. New applications, new equipment, new materials. All on display at New York, June 11-15. Don't miss latest developments in your field. Send for tickets now. Please make request on your company letterhead. (Sorry, no general public admissions.)
Plastics
shaping tomorrow's products
at the new New York Coliseum
7th National Plastics Exposition
sponsored by:
The Society of the Plastics Industry, Inc., 67 W. 44th Street, New York, N. Y.

Thompson Triples Capacity

A new plant has been completed by H. I. Thompson Fiber Glass Co.'s reinforced plastics division at 1611 West Florence Ave., Inglewood, Calif. Complete with special tooling and equipment, the facility is expected to triple the division's production of fibrous glass-reinforced polyester parts. The firm's current products include radomes, ducts, scoops, support assemblies and other aircraft components.

Grace Polyethylene Plant

Ground was broken on March 5, and construction begun on W. R. Grace & Co.'s multi-million dollar polyethylene plant near Baton Rouge, La. The semi-works plant is expected to be in operation this summer, and the commercial production unit should be on stream by mid-1957. Contractor for the project is Fluor Corp., Ltd., Los Angeles, Calif.

The new Grace plant will produce polyethylene under processes licensed from Phillips Petroleum Co. Designed capacity will be 50-million pounds per year, and approximately 300 people will be employed at peak production. Located on a 150-acre site, the installation is near an Esso Standard Oil Co. refinery which will supply Grace with ethylene, the basic raw material used in the process. Additional advantages of the site are said to include excellent transportation facilities; inland-waterway access to the ports of Baton Rouge and New Orleans; and good power and water supply.

Carbide Forms New Division

Union Carbide Development Co. has been formed as a new division of Union Carbide & Carbon Corp., New York, N.Y. Long-term corporate planning and evaluation of new business opportunities will be important objectives of the new division. As in the past, Carbide's operating divisions will continue to carry on their own research and development activities in their major fields of activity: plastics; silicones; chemicals; alloys and metals; electrodes, carbons, and batteries; industrial gases and carbides; and nuclear energy.

Birny Mason, Jr., secretary of Union Carbide, has been appointed president of the new company. R. E. Cornwell, E. J. Fox, and J. J. Murphy have been named vice presidents; all have been with Carbide for many years. Mr. Mason has held various positions in research, production, and industrial relations with Carbide, and was named secretary last year. Mr. Cornwell has been vice president of Linde Air Products Co., one of the Carbide divisions, since 1942. Mr. Fox has held various positions with Carbide & Carbon Chemicals Co., being appointed assistant works manager in 1955. Mr. Murphy has served as vice president of Linde, and is now also director of patent affairs for Carbide.

Macco Chemical's new Wickliffe, Ohio, plant.

New Adhesives Plant Opened

A new, one-story plant has been purchased by Macco Chemical Co., supplier of adhesives to the plastic wall tile industry. Located at 30404 Lakeland Blvd., Wickliffe, O., the facility has modern production and warehouse areas, and an up-to-date shipping system which includes both truck dock and railroad siding for incoming and outgoing materials.

The over-all plant area includes extra land for anticipated additional expansion. Already in full operation, the new unit should enable Macco to expand its research and development program.

Cronar Plant in Operation

The full-scale plant for the production of Cronar polyester photofilm base by E. I. du Pont de Nemours & Co., Wilmington, Del., is now in operation at Parlin, N. J., after about two years of construction. The start-up of the new plant came after eight years of research and development costing more than $6-million.

The plant utilizes a five-story, open-air structure for the chemical mixing and formulation phases of operation. Much of the plant's operations can be monitored from one instrument and control board. A fully equipped product control laboratory is located adjacent to the operating area.

Cronar film base is said to have shown considerably better durability and dimensional stability than any other film base. This dimensional stability is expected to be of particular value in photolithography, photoengraving, and color production work in the graphic arts industry.

Night-time photo of Du Pont's new Cronar photo film base plant in Parlin, N. J.

New Borden PVC Resin Plant

A new PVC resin plant with a prod tion capacity of about 12-million pou per year is being built at Leominster, Ma by the Borden Co., New York, N.Y. T will be Borden's first PVC plant, marki the completion of three years of intens study and development by the compa The plant will be housed in two buildi on a six-acre tract of land adjoining company's monomer department pla which produces polyvinyl alcohol and po vinyl acetate. Construction of the new pla began in January, and is expected to completed in June.

The plant will produce a wide vari of specialty resins and vinyl chloride tices, as well as general-purpose PVC the calendering and extrusion fields.

Durabilt Buys Plastics Firm

The sale of Pacific Plastics Co. to Du bilt Luggage Co., has been announc jointly by the two Seattle, Wash., firm Purchase of the fiberglass-plastics manu facturing concern culminates four yea of research and development by Durab in the field of reinforced plastic lugga

Pacific has been a major supplier of a craft components to Boeing and oth companies, and has developed the Fibe craft line of reinforced plastic boats. R Rosen will serve as president under t new set-up.

Plastic Wall Tile Program

Coinciding with its tenth anniversa the Plastic Wall Tile Industry has unde taken an extensive public relations and me chandising program designed to extend t market for quality merchandise. Th Society of the Plastics Industry's Plast Wall Tile Division is sponsoring the pro gram which will stress the provisions o the U. S. Department of Commerce Com mercial Standard 168-50.

The division intends to vigorously i form customers and the trade that th standard is the yardstick by which the can evaluate their wall tile needs. Stre will be laid on the fact that plastic tile not a substitute or an imitation, but basically new material with inherent a vantages.

Nopco to Erect New Plant

Work has begun on the new plant North Arlington, N. J., which Nopc Chemical Co., Harrison, N. J., is buildi in order to serve the increasing demand fo its line of foamed plastics. Designed fo an annual capacity of three million tons o foamed plastic, the plant will cover an are of 30,000 square feet and house production units, research laboratories, and sales of fices. The building is expected to be read for occupancy by the middle of this year Nopco foams include the Nopcofoam seri of rigid and flexible urethane and vinyl foams, and the Lockfoam foam-in-place systems.

visional Changes at Grace

The establishment of a new company ision and the realignment of existing emical operations have been announced W. R. Grace & Co., New York, N.Y., rough H. S. Ferguson, executive vice sident for the chemical group. The new ision is Polymer Chemicals, which will headed by T. T. Miller, president, and wyn E. Winne, vice president. Ground-aking ceremonies for the construction a polyethylene plant for this division re held on March 5 at Baton Rouge, La. The former Dewey & Almy Chemical . is now divided into three divisions of race. Dewey & Almy operations under e historic name will be headed by G. W. ackwood as president, and W. L. Tag-rt, Jr., as executive vice president. The ryovac Division will have Bradley ewey, Jr., as its president. Dewey & Almy verseas Co., the third division, which ll be responsible for all exports from is country as well as the manufacture d sale of all products overseas, will be aded by H. L. Gilbert, president.

pens New Biochemistry Lab

A new $1.1-million laboratory building r research in biochemistry was opened Dow Chemical Co., Midland, Mich., March 7. The air-conditioned, one-story ilding has a floor area of 46,000 square et and houses 26 laboratories and eight imal rooms. The company's biochemi-l research department, already installed the new building, has a three-fold as-gnment: (1) safeguarding the health of the blic and industrial workers by means exhaustive investigation of proposed emical products and processes; (2) spe-ific research to find and develop new oducts; and (3) basic research in the emistry of living things.

Indicative of the value of this research the plastics industry is the three-year oject carried on by Dow toxicologists check on the safety of Saran Wrap plas-c film for food wrapping. Regulatory gov-mmental agencies checked and accepted ese research findings before the film as placed on the market.

New Plant in Full Operation

Full-scale production of polyethylene be-an on March 19 at the newly-built Port rthur, Tex., plant of Koppers Co., Inc., ttsburgh, Pa. Nearly 200 persons are mployed at the plant, which has an annual ted production capacity of 18-million ounds. Polyethylene in pelletized form is ade at the new plant, located on a por-on of a 1,000-acre site purchased several ears ago. In make-up, the facilities con-st of four major production areas, much whose equipment is of the "outdoor" pe. The buildings also include office, boratory, and service facilities.

Mold Data Forms Developed

The Plastic Mold Makers' Division of the Society of the Plastics Industry, Inc., 67 W. 44th St., New York 36, N. Y., has developed a special quotation-request form for injection, compression, and reinforced-plastics molders. Designed to assist the mold maker in compiling accurate quotations on tool and mold costs, the forms are specific for each of the three above-mentioned operations.

Mold data pads containing 50 of each form are available from the Society at $1.00 per pad. Comments on the inclusiveness of the pads are solicited, and should be directed to the Society's executive vice president, William T. Cruse.

Mobay to Triple Plant Size

Plans to triple the size of its new plant in New Martinsville, W. Va., for the production of chemicals for urethane plastics have been announced by Mobay Chemical Co., St. Louis, Mo. The plant, completed within the past month, will be enlarged in size as rapidly as engineering and construction can be completed. Construction of the present plant started in January and was completed early in February, while some units went into production last November.

Engineering for the additional facilities is more than 50% complete, and the determining factor in the completion data of the expansion will be the availability of critical construction items. The plant produces isocyanates and polyesters, the two main ingredients used in the manufacture of urethanes. Current monthly capacity is several hundred tons of isocyanates and comparable amounts of polyesters.

Lustrex Nomenclature Changes

Some major changes in nomenclature for its styrenes have been announced by the plastics division of Monsanto Chemical Co., Springfield, Mass., through David Guarnaccia, sales manager for styrene molding materials. At the same time, a new medium-flow, medium set-up formulation, Lustrex Hi-Flow 66, has been added to the company's line, and is available in both pelleted and granular crystal forms.

In the general-purpose field, Lustrex L, a regular-flow, fast set-up material, has been redesignated Lustrex Hi-Flow 77. The soft-flow, fast set-up, general-purpose formulation, Lustrex Hi-Flow 55, was not changed in designation.

All Monsanto rubber-modified, high-impact materials are now designated as Lustrex Hi-Test 88. The high-impact line includes 88, 88A, and 88B.

Urethane Foam Pilot Plant

Installation of a complete pilot plant for production of polyurethane foams at the Chicago laboratories of its Emulsol Division gives Witco Chemical Co., New York, N. Y., complete facilities for technical service on the foams. The heart of Emulsol's new installation is an especially designed proportioning-mixing machine. Witco and its divisions have no intention of starting foam production, according to M. A. Minnig, company president, but are interested only in the manufacture of raw materials that will improve the qualities of polyurethane foams. The firm already is producing Witco 77-86, widely used as a coupler in the formation of odor-free polyurethane foams.

New Plant in Operation

Southern Plastics Engineering Corp., Greensboro, N. C., has announced that its new plant began operations on February 23. The firm, which does custom plastics molding by compression, injection, and transfer, was organized late last year. The new plant, especially designed for molding operations, contains approximately 10,000 square feet of floor space. In addition to custom molding, the company also offers a plastics engineering service, and expects to go into vacuum forming, molding of foamed materials, and low-pressure laminating sometime in the future.

The new company is headed by J. W. Worsham, president; Andrew Westhead, vice president; and G. C. Hagblom, plant manager and chief engineer. Mr. Westhead formerly was sales manager of custom molding for General Electric Co., while Mr. Hagblom has had lengthy experience in plastics with Firestone Plastics Co., G-E, and York Corp.

Forms Canadian Subsidiary

F. J. Stokes Co. of Canada, Ltd., Toronto, has been established by F. J. Stokes Machine Co., Philadelphia, Pa., as a subsidiary to carry on its growing operations in Canada. Francis Dougherty, Jr., president of the parent firm, will also head the new subsidiary. Other officers, all of whom hold corresponding positions in the American company, are as follows: vice presidents: F. J. Stokes, Jr., and A. A. Hutchings; secretary, D. E. Stokes; and controller, E. R. Scott. J. W. Robinson, who had been manager of the Stokes Canadian sales office, will continue in charge of operations for the new firm.

Improve Sound of Records

Pliovic vinyl resins, manufactured by the chemical division of Goodyear Tire & Rubber Co., Akron, O., are playing an important role in reducing the background noise level of Full Dimensional Sound L.P. microgroove phonograph records. Capitol Records, Inc., Hollywood, Calif., is using these resins in the production of new long-playing and 45 rpm. microgroove records having as much as 25 decibels less background noise than the standard groove shellac records of the 1930's and 1940's.

Quality-Tag Program for Pipe

A quality-tag program to aid buyers of polyethylene pipe has been inaugurated by Bakelite Co., New York, N. Y. The program offers the buyer a simple, practical means of selecting pipe made from a material designed specifically for use in flexible pipe. A Trefoil hang-tag attached to a coil of flexible pipe identifies it as being made of Bakelite polyethylene developed and compounded for use in water system piping. The tag's two leaves contain the pipe manufacturer's imprint on one side; identification of Bakelite polyethylene as the base material on the other side; and useful suggestions on installation of the flexible pipe in the center.

GATX to Build New Laboratory

The construction of a research and development laboratory in East Chicago, Ind., is planned by the plastics division of General American Transportation Corp., Chicago, Ill. The lab, which will cover an area of approximately 8,000 square feet, will be located at 300 East 51st St., adjacent to the present plastics division plant.

The equipment will include complete facilities for experimental work in the fields of reinforced plastics, compression molding, injection molding, extrusion, vacuum forming, and related operations. Testing equipment for handling all types of plastics will be housed in an air-conditioned, humidity-controlled room. The new lab is expected to be completed and in operation by July 1.

Hetron Sales Transferred

Hooker Electrochemical Co., Niagara Falls, N.Y., has made its Durez Plastics Division sales department responsible for sales of Hetron fire-resistant polyester resins, in addition to Durez's line of phenolics. To facilitate the change, the Hetron sales group has been transferred to the Durez offices at North Tonawanda, N.Y. Charles Y. Cain, former manager of plastic sales for Hooker, has been appointed sales manager for Hetron polyesters.

Consolidation of the Hetron sales group with the Durez Division is expected to result in more complete use of the plastics facilities and experience of the Durez organization. Robert J. Entenman, Hetron sales representative, is being transferred from Niagara Falls to Cleveland, O., as an additional move toward better customer service.

To Build Polyethylene Plant

Koppers Co., Inc., Pittsburgh, Pa., has announced that it will build a multi-million dollar plant having an annual capacity of 30-million pounds of low-pressure polyethylene in Woodbridge Township, N.J. Following approval of the plant site by the company's directors, construction of the plant will begin immediately, with production scheduled for the first quarter of 1957. The new plant will be operated by the firm's chemical division, which has been producing semi-commercial quantities of the plastic at Koppers' Kobuta, Pa., plant.

The plant will be designed, engineered, and constructed by the company's engineering and construction division. The facility will consist of 10 buildings, including various operating units, a laboratory, maintenance and utility shops, warehouses, and offices, and will be operated by some 225 employees.

The production will be marketed under the Koppers trade-name of Super Dylan polyethylene.

Brea-Koppers Joint Plant

Plans for the construction of a $10-million plant in Los Angeles County, Calif., have been announced jointly by Brea Chemicals, Inc., Los Angeles, and Koppers Co., Inc., Pittsburgh, Pa. To be constructed and operated as a joint venture, the plant is expected to be in operation by mid-1957 for the manufacture of a low-pressure polyethylene plastic. The plant will consist of two major units; a plant to make ethylene from refinery gas, and another plant to process the ethylene into the plastic under the Ziegler-process patent license held by Koppers. Ultimate annual capacity of the plant will be 60-million pounds.

Brea will operate the plant with technical assistance by Koppers' chemical division. Koppers will design, engineer, and construct the polymerization units. The refinery gas for the manufacture of ethylene will be supplied by pipelines from the refinery of Union Oil Co. of Calif., of which Brea is a subsidiary. When completed, the plant is expected to employ about 300 persons.

Plastics Output to Triple

Present trends point toward a tripling of plastics production in this country by 1975 to reach an annual level of 10-billion pounds, according to James E. Sayre, manager of marketing for the Barrett Division, Allied Chemical & Dye Corp., New York, N.Y. In a report prepared for the ACS, Mr. Sayre pointed out that current plastics production of 3.6-billion pounds per year approximates or exceeds domestic production of copper, zinc, natural fibers, rubber, aluminum, ceramics, and leather. Current annual output of these materials follows: natural fiber, five billion pounds; copper, 3.6-billion pounds; rubber, 4.5-billion pounds; ceramics, three billion pounds, aluminum, three billion pounds; zinc, 2.2-billion pounds; and leathers, 1.7-billion pounds.

In 15 years, plastics production has been able to challenge or attain virtual parity with output of a dozen standard materials, Mr. Sayre pointed out. He noted that plastics usually have cut in on the older materials in specialized areas but, by providing new products, have served to supplement them as much as replace them. For example, plastics have now replaced some of the metals used in piping, auto bodies, steel panels, etc. Plastics now compete with lumber in decorative board; are used for housings, boxes, and building panels and act as a bonding component in plywood. Various resins compete with rubber in wire coatings, gaskets, and foamed latex products.

Foiltone in Production

Foiltone Products, Inc., a wholly-owned subsidiary of National Research Corp., Cambridge, Mass., is now in production for metallized plastics, and will soon offer metallized papers. NRC has been actively engaged in the development of continuous metallizing processes and equipment for nearly 15 years. Two licensees are presently producing and selling metallized fabric and plastic products, and Foiltone was formed to commercialize certain research achievements of NRC in continuous vacuum metallizing.

According to R. S. Morse, Foiltone president, almost all flexible films are potential base substrates for bright metallic coatings. Foiltone is now offering metallized plastics, including Mylar and cellulose acetate, and will soon offer metallized polyethylene and vinyl films. It is also developing bright aluminized papers for both decorative and functional applications.

Builds New Resin Unit

A new resin unit at its Houston, Tex., plant to manufacture market development quantities of new epoxy resins is being built by Shell Chemical Corp., New York, N.Y. The new unit is expected to begin production early in April. The unit will produce new developmental resins and curing agents for customers' experimental use, and engage in small-scale commercial production.

Sheeting Units in Production

The first units of its new cast sheeting plant in Belvidere, N. J., are now in production, it was announced by Celanese Corp. of America, New York, N. Y. According to E. W. Ward, general sales manager of the company's plastics division, increased quantities of cellulose acetate cast sheeting in thicknesses from 0.005-0.020 inch will now be available to help relieve the tight supply situation which has existed for the past several years. Increased quantities of lightweight cellulose acetate film in thicknesses from 0.0007-0.200 inch also will be available.

Increasing demands for the company's cast sheeting from makers of rigid transparent containers, transparent folders, and the packaging industry in general have far outstripped supply, Mr. Ward said. In busy seasons, shipping dates have been extended to about 12 weeks, and an allocation system has been necessary at times. The new production facilities will result in improved service and help meet the growing demand for Celanese sheeting.

Brief . . .

Technicraft, Inc., Boston, Mass., has announced the availability of three-ounce experimental kits for compounding vinyl plastisols. Ingredients include six different, commonly-used plasticizers plus a barium-cadmium stabilizer. Larger (¾-32 pounds) units also are marketed for the prototype builder, or for short-run specialty production.

Societe de Saint Gobain Chauny and Cirey, Paris, France, has been appointed the exclusive agent in France and Spain for the sale of M. W. Kellogg Co.'s line of fluorocarbon products (Kel-F molding and extrusion materials, dispersions, oils, waxes and greases, acids, and inks). Saint Gobain manufactures silicones in association with Dow Corning Corp., and monomeric vinyl chloride and vinyl polymers under its own process, and imports a number of U.S. products.

Union Carbide & Carbon Corp.'s silicones division, New York, N. Y., has announced a 7½% reduction in the prices of its dimethyl silicone oils and their emulsions. The L-series oils are used as release agents in shell-molding and die-casting processes in the plastics industry.

General Tire & Rubber Co., Akron, O., has named Midwest Floor Coverings, Inc., as its distributor in the Chicago area for Bolta-Floor vinyl floor covering and accessory items. Midwest is located at 1233 West Belmont Ave., Chicago, Ill.

Koppers Co., Inc., Pittsburgh, Pa., has arranged to take over the marketing of textile dyes which have been made and sold by Pittsburgh Coke & Chemical Co. Sales will be handled by American Aniline Products, Inc., a wholly-owned Koppers subsidiary.

Delmonte Plastics Corp., Los Angeles, Calif., West Coast representative for Ciba Co.'s plastics division, has announced the procurement of an additional 10,000 square feet of warehousing space for storing Araldite epoxy resins.

General Electric Research Laboratory, Schenectady, N. Y., has announced the establishment of a European office, with George J. Szasz serving as overseas representative. For the present Dr. Szasz will maintain an office with International General Electric, Ltd., Crown House, Aldwych, London W.C. 2, England.

Auburn Button Works, Inc., Auburn, N. Y., has moved its Chicago office from 4650 W. Lawrence Ave. to larger quarters at 911 Busse Highway, Park Ridge, Ill.

Skeist Laboratories has announced the opening of a new laboratory at 89 Lincoln Park, Newark, N. J. The company specializes in product, process, and market research in the fields of polymers, plasticizers, adhesives, resins, and coatings.

Lunn Laminates, Inc., Huntington Station, N. Y., has been awarded a Navy contract to mold 36-foot LCVPs from reinforced plastic materials. Fabricated of honeycomb-type construction, the plastic boats were chosen primarily for their storage factor and weatherability.

W. Edwards & Co., Ltd. of England, manufacturer of high vacuum equipment, has announced a change in corporate name to Edwards High Vacuum, Ltd. The Canadian subsidiary company, which is located at 17 Jutland Road, Toronto 14, Ont., will be known as Edwards High Vacuum (Canada), Ltd.

Monsanto Chemical Co.'s plastics division, Springfield, Mass., has developed a new pallet for unitized bag shipments. Semi-circular channels are made by splitting a six-inch spirally wound paper core, and then bonding these core segments to a sheet of 90-pound wet-strength Kraft paper.

M. R. Gerow & Associates, Caldwell Township, N. J., is marketing polyethylene lay-flat tubing in widths from 3-5 inches. Films made under the Gerow patent are reported to exhibit excellent slip and clarity, and to be offered at considerable cost savings. At present, only untreated films are available from company.

Dow Chemical Co., plastics division, Midland, Mich., will display uses of Styrofoam expanded polystyrene for perimeter insulation and as a combination insulation and plaster-base material for masonry-constructed homes at the National Association of Home Builders convention and exposition in Chicago, this January.

United States Rubber Co., New York, N. Y., announced a price increase averaging 3% on all vinyl Naugahyde upholstery materials. Effective December 1, the increase ranges from 2-12¢ per linear yard on automotive, furniture, and baby carriage upholstery, and on vinyl materials used for luggage, clothing, handbags, and shoes.

The Society of the Plastics Industry, Inc., has made available an eight-minute film, entitled "The Story of Standard-Quality Vinyl Film," to fabricators and retailers for use in their sales training programs. Among the points covered are gage and textures, best usages, tests, and importance in modern living.

A. Bamberger Corp., and American Molding Powder & Chemical Corp., have announced the opening of their new sales offices and warehouse at 1750 West Wrightwood Ave., Chicago, Ill. Albert K. Speier has been named Mid-Western sales manager.

Injection Molders Supply Co., Cleveland, O., is now stocking IMS Model 3 (½-inch radius) and Model 4 (¾-inch radius) nozzles to enable users of Stokes, Reed-Prentice, and IMS heating chambers to adapt their machine to the widest possible number of mold bases. The new nozzles have 1¾-8 inch threads, and are available with openings from 1/16-7/16 inch.

Newark Die Co., Newark, N. J., has announced the installation of heavier milling equipment for the production of larger molds. Additional floor space and a second shift have been added to facilitate delivery of injection, compression, and transfer molds.

The Dobeckmun Co., Cleveland, O., has announced an average increase of 5% in the price of its flexible packaging materials which feature converted and printed cellophane, aluminum foil, polyethylene, special papers, and laminated combinations of these materials.

Hooker Electrochemical Co., Niagara Falls, N. Y., and its Durez plastics division were made welcome to the city of Kenton, O., at a chamber of commerce luncheon for company officials. The date, October 13, marked the opening of the new $5-million Durez phenolic molding plant.

Premium Plastics Co., Inc., Chicago, Ill., has announced a doubling of its production rate during October. This brings the increase to 800% since Premium's initial output, 14 months ago. The firm is reported to be the only one in the nation producing plastic containers exclusively.

Dow Chemical Co., Midland, Mich., has announced the commercial production of Dow Polyethylene 700° C., a paper coating grade. The new product is being manufactured at the Freeport, Tex. plant.

Reichhold Chemicals (Canada), Ltd., has announced the purchase of 112 acres of land at Millhaven, Ont., as a possible plant site. Located near Kingston, on the St. Lawrence waterway, the plot has ready access to water power and transportation facilities.

News from Abroad

Erosion Tests on Plastics for High-Speed Aircraft

On November 17, 1955, M. G. Church, of the British Ministry of Supply, read a paper on "Some Problems Affecting the Use of Plastics in High-Speed Aircraft," before the London Section of the Plastics Institute. This paper explained the problems presented to the aircraft industry by the growing difficulty of meeting the demands imposed on construction materials by designs calling for progressively faster planes.

Dr. Church emphasized the effects of rain and aerodynamic heating on plastic radomes and cockpit enclosures. All known materials used in aircraft construction erode to different degrees when bombarded by high-speed rain. In general, plastics are rapidly and badly eroded, but even light metal alloys and glass suffer erosion at surprisingly low speeds. At 500 mph., erosion of glass-reinforced polyester laminate is so rapid as to render it useless in a matter of minutes. It has been found that the rate of erosion is proportional to the seventh or eighth power of the speed.

The solution to the difficulty has been sought in protective coatings and a neoprene rubber-type coating has been developed which gives up to three hours of protection at 500 mph. However, this is not an entirely satisfactory solution, and studies of the mechanism of rain erosion under flight conditions have been undertaken both in the United States and in the United Kingdom in the hope that these will further the search for suitable modified laminating resins or more effective protective coatings.

At the Royal Aircraft Establishment, a wide range of materials is being examined in a specially-constructed test rig consisting essentially of a whirling arm near whose extremity the sample is attached. The arm can be rotated up to a maximum peripheral speed of 500 mph. (the usual rate for test runs), and rain drops averaging 1.9 mm. in diameter are used (equivalent to a rainfall of one inch per hour). Work on this test rig has shown that laminates must be void-free for maximum erosion resistance. Even when protected by a neoprene skin, compression failure of a "voidy" laminate will still occur, causing loss of adhesion of the neoprene coating and followed rapidly by blistering and rupture.

A design study is being made of a whirling arm capable of much higher speeds, Dr. Church said, and it is hoped that systematic studies of materials for the reinforced plastic skin and the protective coating will reveal better materials and yield information on the relationship between physical characteristics and erosion resistance which will point the way to still more resistant materials.

Apparatus has also been designed at the R.A.E. for the more detailed study of the erosion of materials by impacting raindrops. This study fires the specimen at a drop of water suspended on an artificial web made from a solution of an acrylic polymer and supported in a vertical plane. It is expected to eventually study impacts over a wide range of velocities, including the supersonic.

Dr. Church next discussed aerodynamic heating resulting from the effect of an aircraft in compressing air and changing its velocity. Calculations showed that flight above 36,000 feet, where the atmospheric temperature is about —56.5° C., would produce boundary layer temperatures under the most favorable conditions ranging from —18° at Mach 1 (equal to the speed of sound) to 530° C. at Mach 4 (four times that speed). At sea level, the range is from 67° C. at Mach 1 to 847° C. at Mach 4.

"The materials currently in bulk production in this country (England) are unsuitable for anything but just supersonic speeds (M 1.2) at low altitudes, and for speeds up to M 2 in the stratosphere," Dr. Church said, in reviewing available transparent organic polymers. Polymethyl-chloracrylate, if developed optically, might permit a maximum speed of M 2.2 under stratospheric conditions, and M 1.4 for low-altitude flights. The suitability of laminated glass is limited by the interlayer; however the possibility of a suitable silicone interlayer offers prospects of speeds corresponding to the temperature of toughened glass (about M 3.2 in the stratosphere, and M 2.4 at low altitude).

Neoprene-protected skin will not be suitable at high temperatures, he went on. For radomes, tri-allyl cyanurate-modified polyesters offer a possibility of producing laminates useful to 180° C., perhaps even 200° C. Silicone resins will resist up to 250° C. or a little higher, but mechanical strength at ordinary temperature is inferior. For sandwich radomes, Dr. Church points to the possibility of foaming phenolic resins and silicone resins. This application is being studied with promising results thus far.

Looking into the future, Dr. Church stated that it is "almost inevitable that . . . we shall eventually have to leave organic polymers and look for other nonmetallic materials." He mentioned mica-reinforced glass for certain radome applications, and the possibility of foaming ceramics. To the chemist, however, the possibility of developing inorganic or nearly-inorganic polymers from which resinous materials with much higher heat resistance could be obtained would be the more interesting [illegible] cites as examples which seem to offer [some] promise, polymeric phosphonitrile in [which] the carbon chain is replaced by alternat[ing] P and N atom compounds (which [have] already been prepared); the diphenyl [com]pound which has so far been prepared [only] as a trimer, but is stable at 500° C.; [com]pounds containing the phosphorous-boron bond (these have been studied, but so [far] only low polymers have been obtained) and low silicone polymers which are stable at 450-500° C.

St. Eric's Fair, Stockholm

A number of foreign countries, including the United States, Czechoslovakia, Denmark, Germany, Israel, Italy, Jugoslavia, Netherlands, and Russia, were represented at the St. Eric's Fair, held in Stockholm, Sweden, on August 27 to September 11, 1955. Special centers of attraction were the large American pavilion featuring plastics in numerous applications in the exhibition on "Americans at Home."

Foamed plastics, plastic toys, decorative plastic film and artificial leather, and extruded silicone tubing and profiles were seen at the West German section, also a few machines for the plastics industry.

The goods displayed by Swedish manufacturers gave evidence of Swedish interest in the newer plastics. Among those drawing special attention were three materials for the building industry: Styropor polystyrene foam in the form of sheets and shaped parts intended chiefly for insulation purposes, and made by Nordiske Frigolit A. B., Holmstad; laminated wall and floor coverings made from veneers of wood chips with top and intermediate layers of flexible PVC film and a backing of pasteboard or textile fabric (made by A. B. Veniryl, Ltd., Norrkoping); and compound sheets for interior uses, consisting of a thin surface layer of laminated paper and an aminoplast on a thicker backing of wood fiber (made by Ji-Te A. B., Astorp). The last mentioned sheets, come in various designs and, while cheaper than the usual all-plastic laminates, are claimed to be easier to cement in place, stiffer, and almost as wear-resistant.

A possible competitor of transparent PVC sheet for covering greenhouses may be the uncolored polyethylene sheet for the same purpose shown by R. W. Nissen A. B., Stockholm. At other Swedish exhibits there were technical goods and parts made from polyamide and PVC; high-frequency welding machines, and some boats of glass fiber-reinforced polyester resin which attracted much interest.

Another reinforced plastic boat and welding machines were on view in the Denmark section. Machines for the plastics industry were shown by Italian manufacturers; PVC material and semi-finished goods of PVC were featured by Jugoslavia; injection molding compounds by Czechoslovakia; and silicone products for waterproofing masonry and fabrics of PeCe fiber by East Germany.

NAMES in the NEWS

John J. Halvorsen

John J. Halvorsen, formerly technical director of plactic pipe and fittings for Continental Can Co., has joined Orangeburg Mfg. Co., Inc., Orangeburg, N. Y., as manager of sales and development for the company's new plastic pipe division. His industrial experience also includes service with Crane Co. as supervising engineer of metal and plastic pipe, fittings, and flanges.

John Porter has been appointed a sales representative for Baldwin-Lima-Hamilton Corp., Philadelphia, Pa. To sell BLH presses and power tools in the New England district, **Mr. Porter** will be based at the company's New York City office and serve the states of Maine, Vermont, Massachusetts, Rhode Island, and Connecticut. A graduate of Swarthmore College, **Mr. Porter** has been with BLH press engineering since 1952. **A. F. Moore,** who formerly served the New England district, will concentrate his activities in New York State and Northern New Jersey.

R. C. Seanor

R. C. Seanor has been named vice president in charge of engineering for Adamson United Co., Akron, O. He had been in charge of engineering at the Akron plant since 1950.

Richard S. Light has been elected vice president in charge of manufacturing for Plax Corp., Hartford, Conn. He joined the firm last year as general factory manager. Prior to that time, he served as vice president in charge of production and procurement for the Snow Crop Division of Clinton Foods.

Charles A. Heiberger has been appointed manager of the plastics and polymers department for Food Machinery & Chemical Corp.'s central research laboratory, which is presently under construction at Princeton, N. J. **Dr. Heiberger** has served as research director for the firm's Ohio-Apex division, Nitro, W. Va., for the past ten years.

Roy T. Cucullu has been appointed representative for Columbian Carbon Co.'s line of Mapico synthetic iron oxide colors in the area around New Orleans, La.

William Murphy

William Murphy has been appointed production manager for Bolta Products, division of General Tire & Rubber Co., Lawrence, Mass. He previously served as assistant production manager for Bolta, and as manager of Goodall-Sanford's plastics division.

Harry J. Karakas has been appointed manager of the process equipment division of Rodney Hunt Machine Co., Orange, Mass. Before joining Hunt, **Mr. Karakas** was director of project engineering sales for Pfaudler Co. In his new position, he will be responsible for application, development, engineering, and sales activities of the division.

Alfred M. Bretschger has been named manager of the Vancouver plant of Becco Chemical Div., Food Machinery & Chemical Corp., Buffalo, N.Y. A graduate of M.I.T. and the University of Buffalo, **Mr. Bretschger** has been with Becco since 1948 in various engineering and production posts. In his new position, he replaces **Henry P. Vogt,** who becomes manager of Becco's main plant in Buffalo.

J. Frees Brossy has joined Houze Glass Corp., Pt. Marion, Pa., as a plastics research engineer. He was formerly with Glenn L. Martin Co. and the Englander Co.'s plastics division.

Louis Miller Sherman

Louis Miller Sherman has joined Thiokol Chemical Corp., Trenton, N. J., as manager of the market development department. He previously served as associate director of product development for Ethyl Corp.; as assistant secretary of Chemical Construction Corp.; and in various chemical engineering capacities with American Cyanamid Co. and E. I. du Pont.

Trevis V. Rankin and **Sondol E. Werner** have been appointed by Colton Chemical Co., Cleveland, O., as technical service representatives for the west coast and east coast, respectively. **Mr. Rankin,** who has 20 years of chemical industry experience, will serve the Far West and Rocky Mountain regions from his headquarters at Emeryville, Calif. **Mr. Werner,** who has been with U. S. Industrial Chemicals and Archer-Daniels-Midland Co., will cover the entire east coast and work from headquarters in Newark, N. J.

John J. Ziccarelli has been appointed to the technical sales department of Glyco Products Co., Inc., New York, N. Y. He has been assigned to the New York office, and will assist in covering Metropolitan New York, Eastern New York State, and northern New Jersey. A graduate of Purdue University, **Mr. Ziccarelli** was formerly with California Texas Oil Co. and Socony Mobil Oil Co. in technical service and development work.

George H. Taft has established a personal consultant service in Concord, Mass., for the assistance of management in the chemical and plactics industries. Until recently vice president of Deecy Products Co., he was formerly in research and development with B. F. Goodrich Co., and manager of chemical purchases for B. F. Goodrich Chemical Co.

John F. Snyder, Jr.

John F. Snyder, Jr., has been appointed works manager at the Kenton, Ohio, plant of Hooker Electrochemical Co.'s Durez Plastics Division. He had been serving as superintendent of the Kenton plant since its construction in 1954.

Gene E. Matz has been named assistant to the president of Popular Plastic Products Corp., Northport, N. Y. He will act as a liaison between the company's departments, and also assist on customer relations. He was formerly with Plastic Molding Powders, Inc.

John L. Patterson has been appointed manager of the newly established sales promotion department, plastics division, Celanese Corp. of America. Former salesman for the firms Marco polyester resins, he will be responsible for promotional activities and the coordination of the sales and advertising programs of the plastics division.

D. F. Oakes has been appointed sales manager of Edwards High Vacuum (Canada), Ltd., Toronto, Ont. The firm manufactures high vaccum equipment, rotary pumps, diffusion pumps, fittings, and instrumentation.

Fritz J. Nagel

Fritz J. Nagel has been appointed vice president of Polymer Processes, Inc., Reading, Pa., a subsidiary of the Polymer Corp. He joined the firm after two years as director of research at Congoleum-Nairn, Inc. **Mr. Nagel** will direct the development of the new Whirlclad coating process, and serve as technical assistant of the president of the parent organization.

Henry H. Reichhold was named chairman of the newly formed executive committee of Reichhold Chemicals, Inc., White Plains, N. Y. Other board appointments included **Stefan H. Baum** as executive vice president, and **Herbert W. Mason, Jr.,** as vice president and general manager.

R. G. Kelso and **Richard H. Proctor** have joined the sales staff of the chemical division, Emery Industries, Inc., Cincinnati, O. **Mr. Kelso** was associated with Carbide & Carbon's research laboratories, and with its technical sales staff. **Mr. Proctor** served as group leader of Koppers' Monica, Pa., laboratories, and as salesman for Fischer Scientific Co.

Robert C. Davenport has become vice president and general manager of Plastics Products Corp.'s sheet forming division, Bedford Heights, O. Formerly associated with Gregstrom Corp., Bolta Products, and Hercules Powder Co., **Mr. Davenport** has a wide range of experience throughout the plastics industry.

Photos: Studio of the N.Y. Times

J. N. Grove W. H. Hough

W. H. Hough and **J. N. Grove** have been appointed managers of the newly-established eastern and Detroit district offices, respectively, for Barrett Division, Allied Chemical & Dye Corp., New York, N. Y. The eastern district will service sales territories in the New England states, Middle Atlantic states, West Virginia, and Eastern Ohio. The Detroit office will serve the midwest and southwest. **Mr. Hough** formerly was a sales representative for Barrett, while **Mr. Grove** was a special representative for Plaskon polyester resins and oils.

Gordon E. Ketring has been named assistant to the western sales manager of the chemical division, Borden Co., New York, N. Y. He previously was in charge of the company's Washington industrial adhesives sales.

David Healy, representative for Taylor, Stiles & Co. in northern New York and parts of New Jersey, has added the five boroughs of New York City and Long Island to his territory.

Thomas J. Lamond

Thomas J. Lamond has been appointed vinyl production manager for General Tire & Rubber Co.'s Bolta Products division, Lawrence, Mass. Former chief chemist and calendering superintendent for the division, he will supervise the production of Bolta-flex and Bolta-Wall.

James C. White has resigned as president of Eastman Chemical Products, Inc., to accept the office of chairman of the board. He will continue as president of Tennessee Eastman Co. and Texas Eastman Co., manufacturing divisions of Eastman Kodak Co. **William S. Vaughn,** first vice president, was elected president and a director of Eastman Chemical Products. He will continue to act as first vice president of the aforementioned manufacturing divisions.

L. J. Polite, Jr., has been appointed product sales manager for Diamond Alkali Co.'s chlorinated products division, succeeding **W. B. Beeson, Jr. Mr. Beeson** was recently named manager of Diamond's New York-New England branch sales office in New York City. **Mr. Polite** previously served as agricultural chemicals sales manager.

N. A. Ruston, director of development and service for Emery Industries, Inc., Cincinnati, O., has retired after 26 years of service; however, he will continue to act in a consulting capacity. **Mr. Ruston** is succeeded by **W. T. Meinert,** assistant director of the department, who will now be responsible for market development and technical service activities.

Merrill Chase

Thomas J. LaBounty

Thomas J. LaBounty has been elected vice president of Bee Chemical Co., and its wholly-owned subsidiary, Logo, Inc., Chicago, Ill. His major responsibilities will be customer relations, sales, advertising and market analysis.

Clarence W. White, Jr., sales representative for Eastman Chemical Products, Inc., has been transferred from Kingsport, Tenn., to the New York City office. He replaces **J. B. Williams,** who takes charge of the new plastics division sales office in Atlanta, Ga.

John A. Wilson has been elected assistant secretary of Diamond Alkali Co., Cleveland, O. He formerly served as attorney in the legal department of Dresser Industries, Inc., and as secretary of Affiliated Gas Equipment, Inc.

R. J. Southwell

R. J. Southwell has been named president and a director of Canadian Resins & Chemicals, Ltd., Montreal, Que., succeeding **V. G. Bartram** who has retired. **Mr. Bartram** also has retired as president of Shawingigan Chemicals, Ltd. **Mr. Southwell** joined Canadian Resins in 1948 as sales manager; was appointed a vice president in 1954; and became executive vice president last year.

New Materials

Write item numbers on Readers' Service Card to obtain more information.

Wipe-On Epoxy Paste Filler

Epocast H-991A filled epoxy resin, a recent introduction by Furane Plastics, Inc., has been utilized as a wipe-on paste for filling voids in epoxy and polyester laminates. White in color, the material will dry in less than one hour.

Suggested formulation calls for 12 parts Hardener 941 to 100 parts of the resin. A limited pot life of 15-20 minutes suggests immediate application. Epocast H-991A is spread over the area with a flexible straightedge or squeegee until all pits and imperfections are filled, and then wiping off the excess. Shrinkage is reportedly negligible.

Readers' Service Item M-1

Secondary Vinyl Plasticizer

A secondary plasticizer, reportedly offering economy, ease of handling, and good color and odor characteristics in vinyl formulations, has been introduced by the petrochemical department of Continental Oil Co. Designated Conoco H-300, the new material is said to exhibit superior heat and light stability and low-temperature flexibility when used in conjunction with dioctyl phthalate.

Evaluation studies have been conducted primarily with plastisols; however, preliminary tests indicate its usefulness in dry-blend mixes. Mixtures containing Conoco H-300 show significantly lower initial and aged viscosities. Extractability is low with soap solutions, and high with hydrocarbons. An oily, light straw-colored liquid, H-300 gives evidence of a low-order volatility, excellent wetting properties, and good tensile strength when used to replace up to 25% of the primary plasticizer in vinyl formulations.

The following typical physical properties are reported for the material:

Odor	Mild
Specific gravity @ 100° F	0.865
Molecular weight	300
Bromine number	0.4
Aniline point, ° C	30
Viscosity @ 100 F., cps	19.9
Flash point, ° F.	335
Freezing point, ° F.	—40
Distillation range, ° F.	600-740

Readers' Service Item M-2

Trowelling & Splining Epoxy

A tooled-in-place epoxy resin, said to permit plastic fillets which blend smoothly into changing contours, has been introduced by Marblette Corp. Designated #631A, the resin is spread over the pattern and smoothed over with a waxed, chrome-plated spherical ball. The cured fillets bond permanently in place, reportedly without shrinkage.

The material has the consistency of putty when mixed with the hardener. For splining master mock-ups and related tooling, #631 is used to build up within 1/16-1/8 inch of the finished template line. A face-coat of white resin #633 should be applied after the first coat is tack-free. The resin is also used for bridging, reinforced corners, and for making laminated stretch dies with foamed cores. Suggested formulation is 100 parts of resin to 12 parts, by weight, of #665 hardener. Cure is effected at room temperature.

Readers' Service Item M-3

Electrical Grade Polyethylenes

The Petrothene 300 series of electrical grade polyethylenes has been introduced by U. S. Industrial Chemicals Co. Designated Petrothenes 300, 301, and 302, the materials are said to meet specifications for infantry field wire, line wire, and TV lead-in wire coverings; high-frequency and high-voltage insulation; and wire and cable jacketing.

All three types are available with antioxidant, with antioxidant and carbon black, and in other colors both with and without a non-discoloring antioxidant. Over-all property data is unpublished as yet; however, specifications are said to fall within the typical limits of electrical-grade polyethylenes. Differences between the three types are based on melt indexes for uncompounded materials. Petrothene 300 has a melt index of 0.3; 301 has an index of 1.0; and 302's index is reported at 2.8.

Readers' Service Item M-4

Polymerizable Vinyl Dispersant

A high-boiling, low-viscosity monomer, said to be an excellent dispersant for plastisol-grade vinyl resins, has been introduced by Carbide & Carbon Chemicals Co. Designated Monomer MG-1, the material is polymerized during fusion of vinyl plasti-

Pleasing Odor = More Sales

consider resodors*!

RUBBER PLASTICS

A soft talc odor helps sell baby pants. A soap-fresh fragrance adds buy-appeal to shower curtains. Hand bags with a simulated leather odor have a real competitive advantage.

Perhaps an appealing odor—or freedom from objectionable odor—is just what your product needs!

SINDAR can give you expert assistance. Our RESODORS were specifically developed for use in plastics and rubber. They are easy to use—just add the oil at any convenient point in your process. They'll stand up under your temperatures too.

There's a RESODOR to give your product exactly the right odor appeal. May we send you samples and put our experience to work for you?

* Reg. U.S. Pat. Off

SINDAR® Corporation

Industrial Aromatics and Chemicals

330 West 42nd Street • New York 36, New York

sols to form a hard end-product which retains no plasticizing action.

MG-1 has a volatility of the same order as DOP, and may be used alone or in blends with conventional plasticizers. Products of any desired degree of flexibility or rigidity can be obtained by varying the concentration of MG-1 in the plasticizer blend. Through the use of proper inhibitor-catalyst combinations, an induction period in its polymerization can be effected. By making this period slightly shorter than the total processing time, very stiff or hard compounds are produced.

The polymerization reaction is mildly exothermic, and a peroxide catalyst in a concentration of 1-3% may be required to obtain adequate cure. Cobalt accelerators may be used; however, they should never be pre-mixed as an explosion could result. MG-1 contains a small amount of hydroquinone as a polymerization inhibitor. This permits storage, and need not be removed before use.

Typical physical properties are reported as follows:

Viscosity @ 25° C., cps.	12.2
Specific gravity	1.078
Color, Gardner	3
Refractive index @ 30° C.	1.459
Weight, lbs./gal.	8.5
Volatile loss at 375° F., mgs./sq. cm. of surface	10

Readers' Service Item M-5

Two Liquid Epoxy Hardeners

Two general-purpose epoxy catalysts, designated Dion RP-7 and Dion RP-22 and based on metaphenylene diamine and 4,4-methylene dianiline, respectively, have been placed on the market by the Chemical Process Co. Being thin liquids they effect a considerable reduction in the viscosity of epoxy resins and, thus, increase their pot life.

All operations are conducted at room temperature. RP-7 is mixed with the resin in the ratio of 17:100; RP-22 requires 21 parts per 100 parts of resin. Being heavier than the resin, the hardener sinks to the bottom; a factor which is said to facilitate mixing. Cure is effected in 24-48 hours at ambient temperatures; however, a heat cure of 1-2 hours at 250-300° produces a more heat-resistant product.

Physical properties are reported as follows:

	RP-7	RP-22
Viscosity @ 20°C., Zahn Cup, cps.	35-40	140-150
Specific gravity	1.187	1.170
Pot life, hrs.	10-11	10-11
Storage temperature, °F.	65-130	50-130
Freezing point, °F.	65	Supercools

Readers' Service Item M-6

Primary Monomeric Plasticizer

A monomeric, low-volatility plasticizer, which is said to feature stability and permanence in applications subject to above-normal atmospheric conditions, has been introduced by Godfrey L. Cabot, Inc. Called Cabflex HS-10, the material is an alkyl aryl phthalate ester developed by a new process, which decreases volatility without sacrifice of processing characteristics and compatibility.

The new plasticizer reportedly has electrical properties superior to DOP, and long-term, high-temperature aging tests have demonstrated its excellent resistance to oxidation and heat breakdown. Intended primarily for vinyl wire-insulating compounds rated above 90° C., HS-10 is compatible with nitrate, butyrate, ethyl cellulose, methacrylate, styrene, PVC, PVA, and vinylidene chloride.

Vinyl electrical formulations containing HS-10 were compared with standard 105° C. compounds, and shown to have 10 times the volume resistivity of the polymeric plasticized materials. Tests run on 15-mil sheets aged 14 days at 121° C., and 60 days at 113° C., showed similar elongation retention.

Physical properties are quoted as follows:

Molecular weight	500
Specific gravity	1.053-1.056
Weight, lbs./gal.	8.8
Flash point, Cleveland, °F.	457
Fire point, Cleveland, °F.	510
Boiling range, °C.	262-288
Pour point, °C.	—35
Refractive index @ 20° C.	1.517
Acidity as acetic acid, %	0.01
Hydrolysis, 24 hrs. @ 100° C.	None
Moisture, %	None
Viscosity @ 20° C., cps.	378
Odor	None

Readers' Service Item M-7

Thermoset Resin Component

Monsanto Chemical Co.'s organic chemicals division has announced the commercial availability of Bisphenol A, a raw material used in the manufacture of epoxy resins. It also serves as an intermediate in the production of oil-soluble phenolics. Physical properties and a content analysis reveal the following data:

Appearance	White flakes
Odor	Slight
Melting point, °C.	150-155
Boiling point, °C.	220
Crystallizing point, °C	154
Phenol content, %	0.3
Moisture content, %	0.2
Ash content, %	0.02
Iron, parts/million	3
Color, APHA	30
Heat stability	Excellent

Bisphenol A is soluble in acetone and alcohol, slightly soluble in carbon tetrachloride, and practically insoluble in water.

Readers' Service Item M-8

specify
RC COMONOMERS
Unsaturated diesters of high purity available in commercial quantities for use as comonomers in polymerization reactions.

DIOF *Di-iso-octyl Fumarate*
DOF *Di-2-ethyl hexyl Fumarate*
DBF *Dibutyl Fumarate*
DIOM *Di-iso-octyl Maleate*
DOM *Di-2-ethyl hexyl Maleate*
DBM *Dibutyl Maleate*

Ready...reliable... RC serving American industry, since 1930

WRITE FOR SAMPLES! We'll send you a brochure on all RC products that can speed your operation, improve your finished products.

RUBBER CORPORATION OF AMERICA
New South Road, Hicksville, N. Y.
Sales Offices: NEW YORK • AKRON • CHICAGO • BOSTON

Three Film-Grade Polyethylenes

Three film-grade polyethylene resins have been placed on the market by Spencer Chemical Co. Designated Poly-Eths 2205, 2215, and 2235, the materials are said to produce films of excellent clarity, impact strength, and flow properties. They are supplied in the form of ⅛-inch cubes.

Poly-Eth 2205 is intended for drum liners, protective covers, packaging of soft goods, and as a moisture-barrier under floors. Poly-Eth 2215 combines a desirable balance of slip and block-resistance properties with clarity and impact strength. Poly-Eth 2235 is similar to 2215, but has slightly better slip resistance. Average property values for the three grades, as determined by ASTM test methods, are reported as follows:

Melt index, gms./10 min.	2
Specific gravity	0.92
Ultimate tensile strength, psi	1,850
Elongation, %	550
Yield strength, psi.	1,220
Brittle point, °F.	—148
Softening point, °F.	208
Power factor	0.0002
Bulk factor	1.76

Readers' Service Item M-9

Heat-Activated Foam Powder

A formaldehyde condensation-type powder which will foam-in-place has been developed by Emerson & Cuming, Inc. Known as Eccofoam GL, the material is pre-catalyzed so that it will set up with heat alone. Finely-divided and free-flowing, the powder is poured into cavities, such as radome walls, which it fills uniformly and completely. It is also used for the imbedment of electronic assemblies.

Properties of Eccofoam GL at a density of 20 pounds per cubic foot are reported as follows:

Dielectric constant @ 10^{10} cps	1.48
Dissipation factor @ 10^{10} cps	0.009
Compressive strength, psi	600

Readers' Service Item M-10

Three Epoxidized Olefins

Three long-chain, epoxidized olefins, which will undergo polymerization, isomerization, reduction, and ring-opening with a variety of active hydrogen compounds, have been introduced by Becco Chemical Division, Food Machinery & Chemical Corp. The materials are octylene oxide, dodecene oxide, and C_{16}-C_{18} oxide; each of which contains a three-membered epoxy ring and is epoxidized in-situ from a preformed peracid.

Octylene oxide is a high-boiling solvent which combines the properties of a hydrocarbon with those of an internal ether. It can be used for the stabilization of chlorinated products, and as a plasticizer for PVC. Soluble in lubricating oils, octylene oxide is of interest in synthetic lubricant manufacture. It lowers the viscosity of epoxy resins, and reacts with the curing agent to form an integral part of the finished resin. Bifunctional, the material is useful in the preparation of modified alkyds, polyesters, and other glycol esters.

Uses for dodecene oxide and C_{16}-C_{18} are similar to those given above; however, no mention is made of their use with epoxy resins. Property data is reported as follows:

	Octylene oxide	Dodecene oxide	C_{16}-C_{18} oxidene
Assay, % oxirane oxygen	11.8	7.7	5.7
Freezing point, °C.	—50	—10 to —12	14-15
Boiling point @ 45 mm., °C.	76-78	—	—
At 3.5 mm., °C.	—	97-98	—
At 0.5 mm., °C.	—	—	110
Refractive index @ 25°C.	1.416	1.4347	1.4446
Solubility, water	Slight	Insoluble	Insoluble
Hydrocarbons and common solvents	Soluble	Soluble	Soluble
Flammability	Flammable	Flammable	Flammable

Readers' Service Item M-11

VANSTAY

Vanderbilt Materials for Vinyls

VANSTAY C Provides efficient heat stabilization at low cost in tile formulations.

VANSTAY L Recommended for maximum light stability and improved natural ageing in all vinyl resin compositions.

VANSTAY HT—VANSTAY S This combination provides excellent heat protection for vinyl compositions during processing and in service.

VANSTAY N Recommended for use with Vanstay S in non-plating heat stabilizer systems.

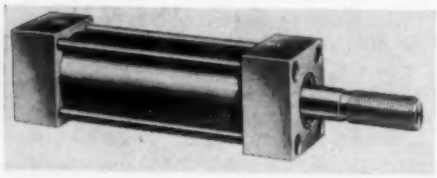
VANCIDE 89 Non-metallic fungicide and bactericide effective in vegetable plasticized vinyls.

Our Technical Service Representatives will gladly demonstrate the merits of our materials in your plant and assist in solving production problems.

R. T. Vanderbilt Co., Inc. 230 Park Ave. • New York 17, N. Y.

New Equipment

Write item numbers on Readers' Service card to obtain more information.



Alkon Model "D" double-acting cylinder.

Double-Acting Steel Cylinder

A new series of double-acting cylinders, featuring a non-metal, nylon contact between the piston and cylinder wall, has been introduced by Alkon Products Corp. Designated Model "D," the cylinders are available with 1¼-, 1¾-, 2½-, and 3½-inch bores; both stock cushioned and non-cushioned; with pivot, foot, flange, or rod-clevis mounts; and as double-ended cylinders.

The cylinders are designed primarily for pneumatic and hydraulic equipment, and are capable of operating under pressures of 250 (air) and 500 (water or oil) psi. The cylinder barrel is chrome-plated seamless steel; the head is machined from high-tensile extruded aluminum; and the piston rod is of polished stainless steel. A nylon bearing wrapped around the piston prolongs cylinder life, and self-adjusting piston packings of Block-Vee design practically eliminate break-out friction.

A cadmium-plated spring, spherical radius seal, and chamfered seat assure positive cushioning with immediate acceleration on the return stroke. One-inch stroke is standard; however, adjustable cushions for controlled strokes up to six inches are available. Three-way flush rabbet mountings, front, rear, and horizontal, are included as standard equipment.

Readers' Service Item E-1

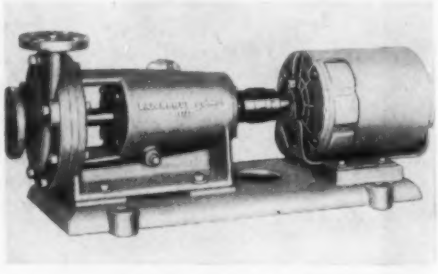
Small-Scale Horizontal Pumps

A line of horizontal, high-head, centrifugal pumps has been introduced by Lawrence Pumps, Inc. Designated Midgets A, B, and C, the small-capacity units are interchangeable with respect to shaft, seal, bearings, frame, coupling, and sub-base. The nominal range of capacities and heads for the different sizes is reported as follows:

	Midget A	Midget B	Midget C
Speed, rpm.	1,750-3,500	1,750-3,500	1,750-3,500
Capacity, gms./min.	5-10	6-12	20-40
Head, ft.	25-100	37-148	40-160
Motor, hp.	0.25-1	0.5-2	0.75-5
Suction size, in.	0.75	0.75	1.25
Discharge size, in.	0.75	0.75	1

The pumps feature heavy-duty construction, including extra heavy shaft and bearings and an open, non-clogging impeller. Size change is reportedly simple, requiring only a change of casing, impeller, and possibly the motor. All wetted parts are made of L-20 stainless steel which is particularly resistant to corrosive solutions.

Packing problems are avoided through the use of an external mechanical seal. Any leakage is caught in the cavity around the seal and drained into the leak collector. Sealed, pre-lubricated bearings require no further lubrication. The pumps are also available in other alloys, such as Hastelloy, and in plastics.



Lawrence Midget centrifugal pump.

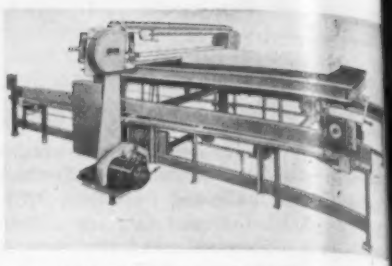
Readers' Service Item E-2

Polyurethane Slab Reducers

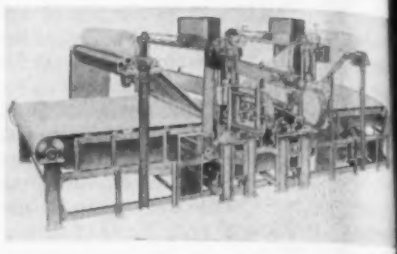
Two new machines which convert huge slabs of polyurethane into sheets and rolls, thus facilitating shipment and fabrication, are presently available from Falls Engineering & Machine Co. Both units were developed by Campbell Machinery Development Co., which designs all special equipment built by Falls.

The Campbell Slab Leveling & Splitting Machine first levels the 10-inch plus slab by making cuts off the top. The saw is equipped with a 0.2-inch thick by ¾-inch wide blade which runs on 14-inch diameter wheels. A guard bar covers all but the cutting edge, and is adjustable from ⅛-10 inches above the belt. The leveling roller assembly, which removes the uneven top-surface of the slab, is interchangeable with the gage roll. This roll is then used for splitting-off sheets of predetermined thickness.

Micro-dial gages give the approximate distances of the blade from the top surface of the belt and the gage roll. A newly-designed mechanism moves the table up and down automatically, synchronizing the table movement with the cutting blade. This feature permits successive cuts without handling the stock.



Campbell Polyurethane Leveling & Splitting Machine.



Campbell Double-Head Self-Indexing Conveyorized Slab Splitter.

The machine is equipped with an 84-inch wide belt, which is powered by a 2-hp. motor through a Reeves variable-speed drive and gear reducer. Belt speed can be varied between 11-44 feet per minute. Three push-button stations are provided, and a reversing starter enables the belt to run in both directions. The machine is 15 feet long by eight feet wide at the conveyor; 146 inches wide at the cutting head. It is wired for either 220 or 440-volt, three phase, 60-cycle motor and control.

The Campbell Double-Head Self-Indexing Conveyorized Slab Splitter also has an 84-inch wide conveyor belt which feeds the polyurethane slabs to two vertically-adjustable splitting heads. Stationed opposite each other in the center of a 14-foot conveyor, these heads automatically adjust themselves to meet the stock as it moves back and forth on the belt. The slab is split to a pre-determined thickness, which can be as thin as 1/16-inch.

With each cut, the split sheet is conveyed to one of the two roll-up units. The machine will handle blocks 25 feet in length; longer blocks when roller conveyors are placed at each end of the belt. Slab stock moves along at the rate of 13-60 feet per minute. The unit is 110 inches wide, 108 inches high, 19 feet long, and weighs approximately 10,000 pounds.

Readers' Service Item E-3

Plasticizing Extruder

An entirely new type of extruder, said to generate up to 80% of the heat in the plastic mass by screw action instead of conduction, has been developed by Abaco Industries, Inc. Designated the Adiabatic, the machine utilizes a special screw, die restrictions, and 2-3 times the conventional extrusion speed. This reportedly results in enough heat being generated to more than double production.

More uniform heating and mixing are aimed for the Adiabatic, as well as elimination of localized overheating and thermal degradation. The standard 2½-inch diameter model is electrically heated; however, oil- or steam-heated machines can be supplied. Other features include a 20/1 length-to-diameter ratio; a solid, one-piece, nitrided-steel barrel; integrally-lined X-alloy barrel; heavy-duty reduction gear box; helical-ground gear; oversize antifriction thrust bearing; U.S. Vari-drive 7/1 ratio 5-95 or 25-175 rpm. starter; removable housing; and relay ammeter for constant-current input reading.

The screw is available in hard alloy, either adiabatic or conventional, and is specially designed for the particular plastic. The control cabinet features four or six electronic pyrometer controls for heat regulation. All individual circuits are harnessed, and wired with circuit identification, and are easily accessible from the front and rear. Other specifications are reported as follows:

Barrel heat, watts	6,000
Width, in.	22
Length, in.	75
Capacity, lbs./hr.	80-120
Weight, without motor, lbs	1,900
Height, in.	41

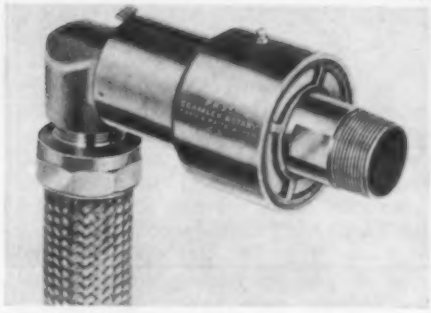
Abaco Adiabatic 2½-inch diameter extruder.

Readers' Service Item E-4

Single-Flow Rotary Joint

A new and reportedly improved rotary joint, designed to convey liquids or gases from a stationary pipe outlet to a revolving cylinder, calender, etc., has been introduced by Seamlex Co., Inc. Designated PR-25, the joint is a single-flow type of heavier construction than earlier models.

The new Seamlex joint is equipped with two ball-bearings which support the revolving shaft and guide it axially. This prevents misalignment and wobbling, and assures continuous leak-proof performance. An external screw adjustment permits compensation for normal wear to be made without removal of the joint itself. A floating graphite seal, bellows-supported and self-aligning in any direction, prevents excessive wear due to misalignment.



Seamlex PR-25 rotary pressure joint.

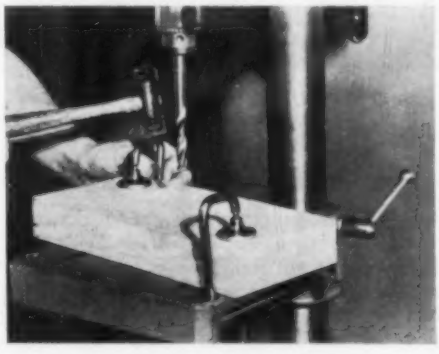
Friction pressure against the rotary seal is reduced by means of a pressure-equalizing chamber. This also provides easy rotation and reduces power consumption. Other Seamlex rotary joints are available in standard sizes from ⅜-2 inches I.P.S., in both syphon and single-flow types.

Readers' Service Item E-5

Self-Locking Drill-Press Clamp

New J-Lock work-holding clamps, designed primarily for use with a drill press, have been introduced by Rockwell Mfg. Co.'s Delta Power Tool division. Positive, hold-down devices, the clamps are installed and locked by the tap of a hammer; removal is accomplished by tapping them a second time.

J-Lock holds materials up to 2½ inches thick, and are said to be especially useful in anchoring long work-pieces laid diagonally across the work table. The clamps are inserted in holes drilled at both ends of the table; the long leg of the inverted "J" entering the hole at an angle, and the short leg pinning the work to the table. By tapping the bottom of the "J" with a hammer, the spring action of the leg is compressed to hold the clamp in position.



Delta J-Lock work-holding clamp.

Readers' Service Item E-6

Flexricin®
"MULTIPLE DUTY" PLASTICIZERS
with the
built-in lubricity factor make vinyl compounding easier

for

- anti-blocking properties
- faster calendering and extrusion
- elimination of other lubricants
- thorough pigment and filler wetting
- improved color in pigmented stocks
- retained low viscosity in plastisols
- outstanding low temperature flexibility

choose

FLEXRICIN P-4 Best secondary plasticizer for general compounding

FLEXRICIN 66 Tops for retention of low plastisol viscosity

FLEXRICIN P-8 Excellent electrical properties; ideal for wire coatings

•

BAKER STABILIZERS
also make compounding easier by imparting effective processing lubrication—moreover contribute to longer life of finished goods.

BVS® (Barium Ricinoleate)
Cadmium Ricinoleate
Calcium Ricinoleate (non-toxic)

For further information on these compounding materials write Dept. PT-46.

The BAKER Castor Oil Co.
120 BROADWAY, NEW YORK 5, N. Y.

New Products

Write item numbers on Readers' Service card to obtain more information.

Nalgene polyethylene labware

Polyethylene Laboratory Ware

Beakers and test tubes, molded of Eastman Chemical's Tenite polyethylene by Ontario Plastics, Inc., have been added to the Nalgene group of specialized items for the laboratory market. Marketed by the Nalge Co., Inc., the products are virtually unbreakable and chemically inert, and may be used in any operation not requiring heat.

The beakers have a full pouring spout and tapering sides which enable them to be nested. Nominal capacity is molded in. The test tubes are designed to withstand higher centrifugal forces than conventional tubes. The beakers are available in sizes from 50-1,000 m. The test tubes measure 75 x 12, 100 x 13, 100 x 16, 115 x 15, 100 x 19, 105 x 29, and 162 x 32 mm.

Readers' Service Item P-1

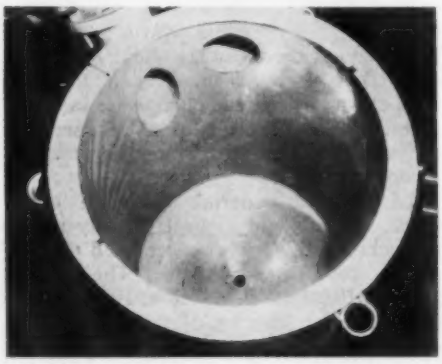
Fluorocarbon-Glass Laminate

A fluorocarbon-glass cloth laminate with high temperature and extreme chemical resistance has been developed by M. W. Kellogg Co. Intended as a lining for tanks, vessels, reactors, drums, pails, pipe, chutes, hoppers, fume hoods, and ducts, the laminate consists of a 10-12 mil film of Kel-F fluorocarbon on glass cloth and can be adhesive-bonded to almost any contoured surface.

Techniques for installing the laminate, as outlined by Kellogg, involve the following steps: cleaning and roughening the surface to which the laminate is to be cemented; cutting and fitting the laminate; applying adhesive to both laminate and supporting surfaces; holding the laminate in place until the adhesive sets; sealing the seams; and testing electrically for the presence of pinholes and incomplete seams.

Fabrication-wise, the sheets can be cut with shears or knife, and can be either cold- or hot-formed to any surface. Economy-wise, the laminate is reported to make carbon steel competitive with many alloy metals. Still lower material costs are expected for lighter-gage laminates used in applications requiring the special anti-sticking qualities of the plastic.

Properties for the laminate are said to parallel those of the fluorocarbon alone. Sheets measuring 36 by 46 inches, as well as custom sheets, are available through Garlock Packing Co. and U. S. Gasket Co.



Kel-F laminate lining for a 75-gallon acid quench tank withstands ice abrasion and temperatures ranging from 0-180° C.

Readers' Service Item P-2

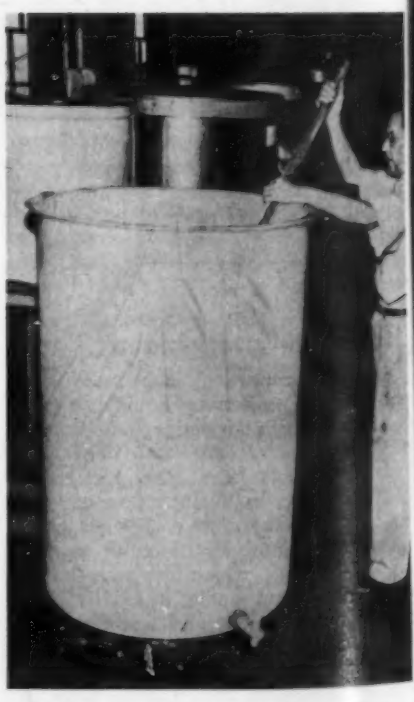
Extruded Polyethylene Liner

A 15-gallon metal drum liner which will withstand corrosive industrial acids has been made from Bakelite's polyethylene by a new extrusion technique, rather than by conventional molding methods. Jet Specialties Co. extrudes the flat sheets which form the circular top and bottom ends, as well as the cylindrical walls of the leak-tight liner.

The liners stand about 19 inches high, and have a diameter of approximately 15 inches. They can be filled or emptied either inside or outside the metal drum. Molded polyethylene pressure cap closures with wing tabs for quick opening, and a pouring spout tube to eliminate spills are provided with the liner. Thirty- and 50-gallon sizes are also available through the manufacturer, Denver Plastics, Inc.

Acid-resistant polyethylene drum liner.

Readers' Service Item P-3



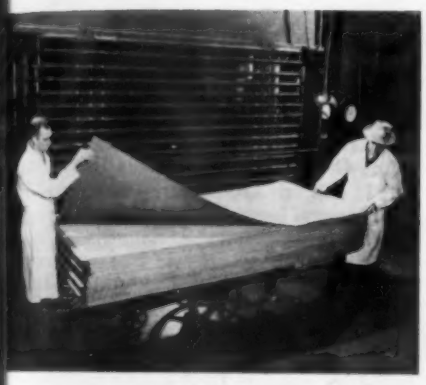
Polyethylene tank with 160-gallon capacity.

One-Piece Polyethylene Tanks

Low-cost chemical tanks with capacities up to 160 gallons are being molded in one piece from Bakelite polyethylene by Delaware Barrel & Drum Co., Inc. Leak-proof and non-corrosive, the new tanks are sufficiently translucent to reveal liquid levels.

Molding these tanks in one piece eliminates the possibility of weak joints, welds, and seams. Rigid enough to be self-supporting, the tanks have wide usage in the mixing, storage, compounding, and processing of foods, pharmaceuticals, salts, water softeners, and cleaing or plating of metal. Outlet valves at the base of the tanks are also polyethylene.

Readers' Service Item P-4



Crezon resin-impregnated cellulose fiber sheets is applied to plywood panel for permanent fusion by the hot press method.

Plastic-Coated Plywood Sheets

A weather-proof, plastic-surfaced fir plywood panel, said to incorporate both increased veneer yield with lower production costs, has been introduced by United States Plywood Corp. Designated Duraply, the panel is faced with Crown Zellerbach's Crezon, a cellulose plastic sheet which is fused to the surface.

Key to manufacture of the product is a new machine which automatically fills knotholes, splits, and other surface irregularities in the base panel with a plastic compound. This eliminates the need for expensive, high-grade surface veneer normally required to provide a smooth foundation for the Crezon overlay. Since second-growth timber and saw logs may be utilized with no sacrifice in quality, costs are cut correspondingly.

Manufacture of Duraply begins with a panel of exterior-type fir plywood, whose waterproof glue meets the rigid performance requirements of the industry's joint quality control program. The patching machine utilizes a plastic formulation developed by American-Marietta Co. Following cure under infra-red reflected heat, the panel is sanded and fused to the Crezon sheet under heat and pressure. The finished panel is said to require one fewer coat than the three conventionally required for an exterior paint system.

Both Crown Zellerbach and U. S. Plywood shared development costs of the patching machine on which joint patents are pending. It will be available under license to other plywood manufacturers in the near future. Duraply is being marketed with one- and two-side plastic surfaces, in four by eight-foot sheets. Thicknesses range from 5/16-3/4 inch. U. S. Plywood will also precut and package special wide-lapped siding with beveled drip edges, furring strips, and ventilation.

Readers' Service Item P-5

Polyethylene Arm-Rest Covers

Arm rest covers molded of Eastman Chemical's Tenite polyethylene are said to provide a smart and attractive way to protect new upholstery or conceal worn arm rests in recent-make automobiles. Designated Easy-Fit, the covers are manufactured by Easy-Fit Corp., in a variety of colors.

The new covers are semi-flexible, and have a soft, resilient surface. Installation is reportedly simple, requiring only the loosening and tightening of the two set screws.

Easy-Fit polyethylene covers feature ease of installation.

Readers' Service Item P-6

Fluorescent Light Diffusers

Extruded polystyrene shields for fluorescent lights, reportedly featuring six times the light stability of conventional styrene shields, have been introduced by Sheffields Plastics, Inc. Accelerated aging tests based on exposure to concentrated ultra-violet light given off by a mercury arc lamp show the shields to retain their initial color, even after 60,000 lighting hours.

Sheffield's UVR grade polystyrene shields for fluorescent light.

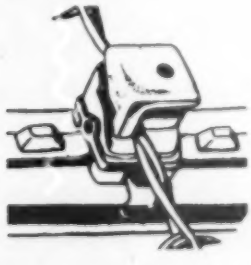
Designated as UVR grade diffusers, the shields are stabilized through the use of a special ultra-violet light-absorbing material which is combined with the plastic on the light-source side during extrusion. In addition, the light stability is reportedly achieved without sacrifice of initial color, hiding power, light transmission, toughness, or satin-smooth finish of conventional shields.

Readers' Service Item P-7

Polyethylene Fence-Insulator

Light-weight electric fence insulators are being molded of Du Pont's Alathon polyethylene resin by Northwest Plastics, Inc. Called Red Snap'r, the insulators are available from North Central Plastics, Inc., in seven different types to fit almost any kind of fence post.

Polyethylene's resilience makes a snap-fit possible, thus reducing installation time. Impervious to moisture, Red Snap'r prevents current leakage and will neither corrode nor crack. The insulators come completely assembled, 25 to a box.



Red Snap'r polyethylene insulator.

Readers' Service Item P-8

New Literature

Write item numbers on Readers' Service card to obtain more information.

"Plaskon Polyethylene Lubricants in Vinyl Processing." Report C-557. 3 pages. Data on vinyl film and sheeting are given to show that the lubricants are more effective than either calcium or lead stearate in vinyl operations.

Readers' Service Item L-1

"Emulsifiable Plaskon Polyethylene." Report C-559. 2 pages. Typical properties and electrical characteristics of Plaskon 8429 are given, together with information on its use in the preparation of low-viscosity polyethylene emulsions.

Readers' Service Item L-2

Publications of Bakelite Co.:

"Extruderitems." No. 3, dated January 1956. 8 pages. This issue is devoted to a description of the company's quality-controlled polyethylene extrusion compound DGD-4011 Black 865 designed for the extrusion of high-quality pipe. Properties of the material are given, together with information on pipe sizes and working pressures, handling, coiling, sizing, extrusion conditions, and joining and fitting.

Readers' Service Item L-3

"Release Agents Lead to Stress Cracking of Polyethylene Film." Technical Release No. 5, dated December 1955. 4 pages. A discussion of findings by a Bakelite development team showing that environmental factors may cause cracking and splitting of certain polyethylene film. Silicone release agents often used on commercial band sealers cause stress cracking when exposed film packages are cramped in a carton. This difficulty can be remedied by use of other types of release agents.

Readers' Service Item L-4

"Your Fact File on Diamond Chlorowax." Diamond Alkali Co. 40 pages. This illustrated manual describes and lists the Chlorowax grades, their physical properties, and principal industrial applications. Tabular data is given on compatibility, heat stability, specific gravity, solubility, viscosity and miscibility.

Readers' Service Item L-5

"Nopco News." Volume 1, No. 1. Nopco Chemical Co. 4 pages. General descriptions, property data, and suggested uses for four new chemicals are offered in this, the first in a series of quarterly bulletins issued by the firm's market development department. Included are a hydroxylated aliphatic amide plasticizer, an alkylated phenol polymer surfactant, an anionic PVA emulsion, and a modified ester of castor oil.

Readers' Service Item L-6

"Hydraulic Machinery." Watson-Stillman Press Div., Farrel-Birmingham Co., Inc. General Bulletin 110-D. 24 pages. Detailed information and photos are given on the W-S line of injection, compression, and transfer molding machines for the plastics industry; extrusion presses for metals; metal-working equipment; railroad ship equipment; ordnance equipment; and other standard and special industrial machinery.

Readers' Service Item L-7

Publications of Heli-Coil Corp.:

"Design Manual and Catalog." Bulletin No. 652A. 22 pages. Complete design data on the company's wire thread inserts are given, together with photographs and tables of sizes, specifications, etc.

Readers' Service Item L-8

"Military Design Manual." Bulletin No. 689A. 16 pages. A supplement to Heli-Coil Bulletin No. 652A, this booklet provides design data for engineers working on military applications of the inserts, and gives military standards on drilling depth, class of fit, gages, etc.

Readers' Service Item L-9

"Kel-F Plastic Laminate." Garlock Packing Co. 2 pages. Description and photos of a new lining material for containers, tanks, pipe, etc. The liner, a laminate of Kel-F plastic fused into a glass fiber cloth backing, is said to be lighter, less expensive, and superior in properties to costly alloy metals for containers. Properties, advantages, and installation of the liner are discussed.

Readers' Service Item L-10

"Quelcor Plastisol Systems for Plant Maintenance," Data Sheet #83. Quelcor, Inc. 2 pages. This illustrated bulletin highlights the advantages and use of Quelcor in-plant systems for corrosion resistance of industrial equipment. The plastisol, the application technique, and the necessary equipment for the maintenance system are explained in detail.

Readers Service Item L-11

"Naphthalene." Chemical Safety Data Sheet SD-58, adopted 1956. Manufacturing Chemists' Association, Inc. 12 pages. A comprehensive discussion of the properties of naphthalene, with essential information for its safe handling and use. Topics covered include shipping containers, unloading and emptying, storage, handling, personal protective equipment, tank and equipment cleaning and repairs, waste disposal, and health hazards and their control.

Readers' Service Item L-12

"Harvest of Research, The Story of The Goodyear Chemical Division," by David Dietz. Goodyear Chemical Div., Goodyear Tire & Rubber Co. 54 pages. The illustrated story of Goodyear's entry into the field of chemical materials; the creation of the Goodyear Chemical Division to serve the rubber, paint, plastics, textile, and paper industries; and the growth and development of the Division, based on research and sound engineering.

Readers' Service Item L-13

"Three Types of Rodney Hunt Evaporation Equipment Operate over the Range from Volatile Solutions to Powder with Infinitely Varied Control." Rodney Hunt Machine Co. Bulletin No. 125. 4 pages. Operating principles, specifications, and product applications are given for the firm's three types of evaporation equipment for the plastics, chemical, petroleum, and other industries. The equipment includes Turba-Film Evaporators, Turba-Film Floating Blade Evaporators, and Hunt-Luwa Spray Dryers.

Readers' Service Item L-14

Technical data reports of Barrett Division, Allied Chemical & Dye Corp.:

"Properties of Plaskon Polyethylene Lubricants." Report C-5510. 2 pages. Tabular data are given on the typical properties, electrical properties, and solubilities of the Plaskon polyethylene lubricants, available in two standard grades, each made in powder and extruded forms, and in a special emulsifiable grade.

Readers' Service Item L-15

Plaskon Polyethylene Lubricants 8406 8407 — Resistance to Chemical ...ids." Report C-558. 1 page. A tabula- ... of the weight changes of the lubricants ...r immersion in 34 chemicals.

Readers' Service Item L-16

Publications of Polychemicals Dept., E. ...u Pont de Nemours & Co., Inc.:

"**'Alathon' Polyethylene Resin Injection ...lding.**" Information Bulletin No. X-19b. ...ages. Information is given on molding ...ipment, mold design, molding condi- ...s, mold shrinkage, and prevention of ...rpage when injection molding Alathon.

Readers' Service Item L-17

"**'Alathon' Polyethylene Resin Extru- ...n.**" Information Bulletin No. X-70. 15 ...ges. Detailed information and data are ...en on the extrusion of Alathon, includ- ...g extrusion equipment, extrusion of flat ...d blown films, extrusion coating, pipe ...rusion, and wire coating. A section on ...uble-shooting includes possible solutions ... problems encountered during extrusion.

Readers' Service Item L-18

"**Polypenco Non-Metallics.**" The Poly- ...er Corp. of Pa. 4 pages. The properties ...d characteristics of the company's full ...e of nylon, Teflon, and specialty non- ...etallics are given, together with stock ...apes and standard size ranges. Specific ...es are described, along with the advan- ...ges of fabricating from stock shapes.

Readers' Service Item L-19

"**Arochlor 1221, 1232, 1242.**" Organic ...hemicals Div., Monsanto Chemical Co. ...chnical Bulletin No. 0-111. 4 pages. ...hree chlorinated polyphenyls especially ...ited for the plasticizing of polyvinyl ace- ...te emulsion adhesives are described. Prop- ...ties, specifications, and laboratory data ...e given to aid in the selection of the ...ost suitable plasticizer for the desired ad- ...sive properties.

Readers' Service Item L-20

"**Marvinol Grade Identification Color ...ode.**" Naugatuck Chemical, division of ...nited States Rubber Co. 1 page. This wall ...hart, in color, serves as an aid in the iden- ...fication of shipping bags of Marvinol VR- ...eries resins.

Readers' Service Item L-21

"**Vacform Model 88.**" Vacuum Forming Corp. 8 pages. Complete specification data and price information is given on the firm's Model 88 and 88-EM vacuum and drape forming machines. Photographs of operational procedures are included.

Readers' Service Item L-22

"**Bondmaster Adhesives—Series M.**" Rubber & Asbestos Corp. 1 page. Technical data, form, percentage solids, average viscosity, optimum curing times and temperatures, and applications are given for 30 of the firm's adhesive formulations used for bonding plastics and metals.

Readers' Service Item L-23

"**Victor Chemicals for Plastics.**" Victor Chemical Works. 28 pages. Designed in the form of a file, it includes a handy, two-page application chart as well as separate data sheets on each of the company's products.

Readers' Service Item L-24

"**Melamine Dinnerware.**" Barrett Division, Allied Chemical & Dye Corp. 4 pages. Applications and advantages of melamine dinnerware for restaurant and institutional service are described in this folder.

Readers' Service Item L-25

"**Epichlorhydrin.**" F-8862A. Carbide & Carbon Chemicals Co. 8 pages. Physical properties, typical reactions, and applications are reported for the material.

Readers' Service Item L-26

"**M & T Chemicals.**" C197R. Metal & Thermit Corp., 6 pages. Formulas, descriptions, and applications for the firm's line of chemicals and other products derived from tin, antimony, and zirconium are contained in this bulletin. New chemicals are grouped separately.

Readers' Service Item L-27

"**Cyclohexanol.**" Monsanto Chemical Co., Organic Chemicals Div. Technical data sheet, dated Oct. 7, 1955. 2 pages. Information is given on the properties, chemical nature, toxicity, handling, and shipping of the chemical.

Readers' Service Item L-28

"**A List of 'dag' Dispersions for Industry.**" Acheson Colloids Co. 4 pages. This bulletin is essentially a chart listing the firm's products, their physical properties, and applications. Materials included are collodial and semi-collodial dispersions of graphite, molybdneum disulfide, mica, vermiculite, zinc oxide, and acetylene black.

Readers' Service Item L-29

"**Diall—A New, Improved Line of Diallyl Phthalate Compounds.**" Mesa Plastics. 10 pages. This folder contains data sheets on eight filled compounds available to the electrical and electronic industries. A physical property chart and a two-page applications list is included.

Readers' Service Item L-30

"**Manual for 'Molding Phenolics'.**" Bakelite Co. 23 pages. Intended to supplement the company's new film, "Molding Phenolics," this booklet provides additional information on phenolic chemistry; molding design; mold types; mold making; preheating; molding time, pressure, and temperature; and the effects of design factors on molding. A glossary of molding terms is included.

Readers' Service Item L-31

"**New Metron Stationary Tachometers.**" Bulletin No. 105. Metron Instrument Co. 8 pages. Design principles and operation of the company's complete line of stationary tachometers is described and illustrated. The instruments have new circuits and new take-off heads that prolong their service life.

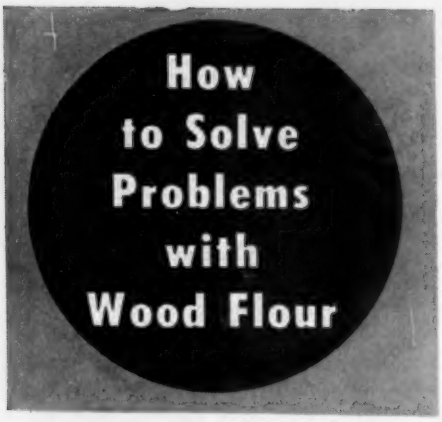
Readers' Service Item L-32

"**Baldwin-Tate-Emery Universal Testing Machines.**" Bulletin 4401. Baldwin-Lima-Hamilton Corp. 12 pages. The company's line of testing machines is described and illustrated. The outstanding feature of this bulletin is an illustrated explanation on hydraulic loading and the independent hydraulic weighing system based on the Emery cell and Tate-Emery null-balance load indicator.

Readers' Service Item L-33

"**Harflex 300, A Permanent Plasticizer of Outstanding Efficiency and Compatibility.**" Harchem Division, Wallace & Tiernan, Inc. 12 pages. Information on the properties and characteristics of the polymeric plasticizer is given, together with basic compounding formulations and typical applications.

Readers' Service Item L-34



Research and Technical Assistance

In a field that is expanding as rapidly as the wood flour industry, research and development effort are vital in enabling the user to adapt wood flour efficiently to new and improved uses.

The Wilner Company maintains a continuing research program in wood flour utilization, supplemented by the services of a leading firm of industrial research consultants.

These services are available at no cost, to help any interested concern in solving development and/or processing problems involving use of wood flour.

Typical Analysis
100 Mesh Wood Flour

Thru	On	
	80	Trace
100		96.0
120		65.2
140		48
170		36.4
200		22

Uses of Wood Flour

Wood flour is a *filler and extender,* adding strength, bulk, lightness and impact resistance to other more costly materials, such as plastics, linoleum, roofing felt, molded rubber products, wall board and vinyl floor coverings. It is an ideal *absorbent* for explosives, adhesives, rug and fur cleaners, stock feeds, and fertilizers (with built in insecticides?), and an effective *mild abrasive,* for cleaning metal surfaces, such as molds.

Other prospective uses include very fine filtration work; as a *binding agent* and *moisture absorbent* in ore processing; as an *anti-binding agent* to give desired porosity after burn-out in products like firebrick.

For samples, further information and specifications, please write:

DEPT. I-1C

Wilner Wood Products Co., Norway, Me.

Book Reviews

"SPE Technical Papers, Volume II." Society of Plastics Engineers, Inc., 34 East Putnam Ave., Greenwich, Conn. Paper, 5⅜ by 8½ inches, 626 pages. Price: $5 to SPE members; $7.50 to others.

This volume contains the texts and illustrations of 56 of the papers presented last January at the Society's Twelfth Annual National Technical Conference. The papers, all contributed, are printed in their original form (without editing), as given in the Conference sessions on injection molding, epoxy resins, properties of plastics, molding and extrusion, thermoplastic sheet, research, extrusion, calendering and coating, reinforcement of plastics, plastic foams, plastic pipe, reinforced plastics, materials, and design.

In its present form, the volume is a compilation of the most recent technical developments in the plastics field. Some of the papers in edited form have been printed in the "SPE Journal" and in other magazines, but this volume presents the 56 papers in one handy book. In addition to mentioning the valuable aspects of this volume, it should be pointed out that eight of the technical papers given at the Conference were not received by the Society in time to be included in this book. The missing papers were in the sessions on injection molding, thermoplastic sheet, research, and reinforced plastics. Another handicap is the lack of a subject index for the volume.

"An Investigation of the Dynamic Mechanical Properties of Polymethyl Methacrylate." Order BP 111642 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 35 pages. Price, $1.00.

Dynamic mechanical properties of polymethyl methacrylate were studied over a frequency range of 6 x 10^{-4} to 1.6 x 102 cycles per second, and over a temperature range of −20° to +80° C. A modified Kimball-type testing machine was used for this research.

Results indicated that three mechanisms of relaxation are involved in the response of the material. The importance of dynamic mechanical properties to the practical engineering design of plastic components is discussed. It is suggested that the best means of describing the mechanical behavior of plastics at use conditions involves the setting-up of three-dimensional plots of modulus or loss factor against frequency and temperature.

"Plastics for Corrosion-Resistant Applications." Raymond B. Seymour and Robert H. Steiner. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. Cloth, 6 by 9 inches, 436 pages. Price, $7.50.

Compiled from the extensive experience and research knowledge of the authors in the plastics field, this book supplies engineers with the necessary background information on plastics for their proper selection and utilization for construction in corrosive atmospheres. Much of the information given is practical know-how based on experience, and presents a complete treatment of plastic and resin coatings, lining, impregnants, adhesives, pipe and structural shapes for numerous industrial applications.

The volume is divided into five sections. Section I, general information on plastics, comprises six chapters dealing with an introduction to the subject; a short history of plastic materials of construction; plastic fundamentals; physical properties of plastics; relation of chemical resistance and molecular structure; and testing of plastics. Section II, on plastic materials of construction, consists of eight chapters covering protective coatings, organic linings, chemical resistant mortar cements, casting resins, cellular plastics, plastic impregnants, industrial adhesives, and reinforced plastics.

Thermoplastic applications are covered in Section III, which has five chapters on thermoplastic structural materials; thermoplastic structures; plastic pipe, valves, and fittings; water-jointing materials, and sewer-jointing materials. Section IV, on applications of plastics in masonry construction, comprises four chapters covering design considerations for concrete floors and tanks; design of steel vessels; chemical resistant masonry construction; and chemical-resistant floors. The concluding section consists of a lengthy chapter dealing with the selection of plastics for the solution of corrosion problems. The book also has both author and subject indices, and the text is illustrated with many photographs, diagrams, and tables of data.

The book will prove of great value to everyone concerned with the fabrication or use of plastics in corrosion-resistant applications. Chemists and engineers will find great use for the vast amount of comparative data on chemical resistance, while users will find the volume an indispensible guide in choosing plastic materials to eliminate or reduce corrosion problems.

Abstracts of Important Articles

aterials

"Theory of Adhesiveness and Mechanical Resistance of Cemented Parts," A. vat-Lahousse, *Ind. Plastiques Mod.*, 7, 37 (Dec. 1955).

The theories explaining the adhesiveness cess that have been advanced by various vestigators are inadequate, since in each se only part of the phenomena occurring adhesiveness is considered, and no disction is made between ungluing and rupre of the adhesive itself. The question ould be viewed as a whole, and in conction with the quantum theories of assoation of the atoms and molecules. The le of the nature of the support, apart om the mechanical resistance required r a structure, is important. The author ints out that purely empirical methods e followed in the cementing of plastics ith organic compounds, and that there ems to be no satisfactory solution for the se of cementing two different thermolastic materials. A suggestion that deserves orough study, he feels, is that made by hinius, who believes that the problem ould be solved by using long-chain molecular substances compatible with one of the upports, while the substitutions would associate with the other support. (In French).

"Mixing Mills and Calenders," A. Fourier, *Ind. Plastiques Mod.*, 7, 8, 27; 7, 9, 25; and 7, 10, 31. (Sept.-Oct., Nov. and Dec. 1955).

A review of the manufacture of cylinders for mixers and calenders, and the development of synthetic rubbers and plastics being considered as a factor influencing construction and design of these machines. There is also a general discussion of mixers and calenders, and brief descriptions of apparatus of various sizes. (In French).

"Methods of Determining Degree of Heterogeneity of Macromolecular Substance," D. Cadorin, *Materie Plastiche*, 21, 8, 630 and 21, 11, 939 (Aug. and Nov. 1955).

This is a review in two parts of the principal methods developed for the determination of the heterogeneity of macromolecular substances. After defining the concept of heterogeneity quantitatively, the author discusses in Part I the fractionation techniques, including solubility methods, and diffusion, chromatographic absorption, ultrafiltration, and molecular distillation. Part II, devoted to analytical methods, covers comparison of average m.w. determined in different ways. (In Italian).

"Measuring Impact Bending Strength on Softened Plastics," W. Holzmuller and P. Jung, *Plaste u. Kautschuk*, 2, 10, 218 (Oct. 1955).

The effect of temperature on impact bending strength was measured by a new method on four plastics; polystyrene, polymethyl methacrylate, PVC, and nitrocellulose. Samples were heated in the Dynstat impact bending tester by blowing hot air onto them under controlled conditions. Measurements showed a considerable increase in impact bending strength for the softened plastics which reached a maximum at a definite temperature. For nitrocellulose and PVC this maximum seems to be room temperature, while for polystyrene and acrylic it is somewhat above the softening points, the maximum being about 20° lower for the acrylic than for the polystyrene. At the same time the tests contributed to knowledge on the molecular migration processes taking place at break, and the energy requirements. (In German).

"Epoxy Resins," J. R. Charlton, *Canad. Plastics*, 31 (Dec. 1955).

The unique properties of epoxy resins have insured their rapid acceptance for a number of purposes. What nature of epoxy resins, and their qualities and uses as stabilizers, coatings, adhesives, casting, and impregnating and laminating resins are explained. Possible new uses as molding resins, and extensions of present uses as paints for masonry and other applications are mentioned. In the latter connection, reference is made to the recommended use in England of epoxy resin with zinc dust as a metal finish for protection against corrosion in marine atmosphere and in sea water.

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines will be printed here quarterly.

The next complete listing will appear in May.

—The Editor

"Epoxy Casting Resins Modified with Polysulfide Liquid Polymer," K. R. Cranker and A. J. Breslau, *Ind. Eng. Chem.*, 48, 1, 98 (Jan. 1956).

Epoxy resins coreacted at room temperature with polysulfide liquid polymers yield flexible compounds which have excellent properties for casting and embedment applications.

"Effects of Glass Fibers on Cure of Silicone Resins," H. A. Clark and K. R. Hoffman, *Ind. Eng. Chem.*, 48, 1, 104 (Jan. 1956).

Data on hydroxyl group condensation are used to provide an insight into the cure of silicone resins when used to make silicone-glass laminates. The types of glass cloths commonly used in making these laminates have measurable surface activities which affect the gelling rate of the silicone resins. Two empirical methods for predicting this effect are given and compared.

"Catalysis of Urea-Formaldehyde Condensation," I. J. Gruntfest and E. M. Young, Jr., *Ind. Eng. Chem.*, 48, 1, 107 (Jan. 1956).

A technique is proposed for meeting the problem presented by the B stage of the resin which must be sufficiently stable to withstand shipping and handling, yet be sufficiently reactive to go over to the C or final stage without the use of severe cure conditions. This technique uses the acid-neutralizing capacity of the solvent to produce a latency of the catalyst.

"Dynamic Investigations on Polymeric Solutions Using Different Methods," W. Philippoff, K. Sittel, J. D. Ferry, and D. J. Plazek, *SPE J.*, 11, 7, 41 (Sept. 1955).

Experimental results show that a determination of the dynamic properties of polymer solutions could be obtained in eight decades of frequency at one temperature. Amplitude effects, if present, are shown to be of minor importance. The three different methods compared give absolute values entirely comparable with each other.

"The Electrical Resistivity of Manufactures of PVC," A. Coen and P. Parrini, *Materie Plastiche*, 21, 10, 850. (Oct. 1955).

Tests on the electrical resistivity of cables insulated with PVC produced by suspension polymerization were carried out in a continuous electrical field. Samples were immersed in mercury, water, and air at 15° C. for varying periods, and up to 100 hours in water alone at temperatures of 15, 30, 50, and 70° C. At the higher temperatures in the water test, initial decrease was followed by an increase in resistivity after a certain period which is thought to be due to extraction of ionic impurities by the water. Tests on the effect of plasticizer content indicated that the absorption increased with the content. Studies on polarization phenomena showed that viscosity is the most important factor in this respect. (In Italian).

"Polymerization Control in Casting a Thermosetting Resin," William R. Dial, William E. Bissinger, Bernard J. DeWitt, and Franklin Strain, *Ind. Eng. Chem.*, 47, 12, 2447 (Dec. 1955).

Addition polymerization of many thermosetting resins, such as diethylene glycol bis (allyl carbonate), poses problems due to the highly exothermic nature of the reaction. This necessitates low temperature reactions over extended periods of time. Cycles of 12-hour duration are considered practical for ¼-inch thick sheet castings, and other polymerization cycles are defined for producing a constant rate of catalyst decomposition and heat evolution.

"Phenolic Resin Process Design," F. W. Hammesfahr, D. C. Johnson, S. N. Johnson, and S. Seltzer, *Modern Plastics*, 33, 6, 139 (Feb. 1956).

It is possible from the known interrelationships of the resin properties to predict the type of resin that will be obtained for any specific set of processing conditions.

"Effect of Fillers on the Dynamical Mechanical Properties of Polystyrene," L. E. Nielsen, R. A. Wall, and P. G. Richmond, *SPE J.*, 11, 7, 22 (Sept. 1955).

Dynamic shear modulus and mechanical damping were measured on polystyrene containing various fillers, such as powered calcium carbonate, mica, asbestos, and wood flour. In general, fillers increase the shear modulus and decrease the damping over that of pure polystyrene. The results can be partially explained in terms of the individual mechanical properties of the polystyrene and filler, and by an "adhesion factor."

"Comparison of Methods for Measuring the Tensile and Tear Properties of Plastic Films," F. W. Reinhart and John Mandel, *ASTM Bull.*, 209, 50 (Oct. 1955).

Results of a comprehensive test program show that tensile strength, SPI-ASTM tear resistance, and Elmendorf tear resistance of plastic films are measurements of three different properties or combinations of properties, and one test method cannot be substituted for another. If used for specification purposes, a different requirement value for each property when tested by each method must be established.

"Temperature, Velocity and Viscosity Distribution for a Temperature Sensitive Viscous Liquid," R. E. Colwell, *SPE J.*, 11, 7, 24 (Sept. 1955).

A procedure is presented for computing the temperature, velocity, and viscosity distributions across a stream of a temperature-sensitive viscous liquid in laminar flow when being sheared between two plane, parallel plates. Use of the procedure for correcting experimental viscosity measurements is described, and application of the procedure to the design and operation of plastic processing apparatus is mentioned.

"Microscopic Examination of Glass Fiber Reinforced Plastics," M. K. Weber, *ASTM Bull.*, 208, 49 (Sept. 1955).

A technique is suggested for microscopic examination of reinforced plastics, similar to that used in metallurgy. The technique reveals features of fine structure and defects not readily apparent by ordinary examination.

"The Analysis of Dynamic Tests of Visco-Elastic Materials," E. H. Lee and D. R. Bland, *SPE J.*, 11, 7, 28 (Sept. 1955).

For analyzing results of dynamic tests of visco-elastic materials, it is shown that it is important to develop the analysis on the basis of a general stress-strain relation, since the particular form of the relation for the material under test is not known in advance and any arbitrary assumptions may lead to contradictions. Such a general method of analysis is discussed for a simple longitudinal stress test and the vibrating reed test.

"Viscous Heat Effects in Extrusion of Molten Plastics," R. B. Bird, *SPE J.*, 11, 7, 35 (Sept. 1955).

This paper shows how Brinkman's method for solving the differential equations of motion and energy balance to describe the heat effects for newtonian flow in capillaries of circular cross-section can be extended to describe the heat effects for non-newtonian fluids which obey a power-law relation between the coefficient of viscosity and the shear stress.

"Dynamic Creep of Plastics," Joseph Marin and W. J. Schuman, *SPE J.*, 11, 7, 18 (Sept. 1955).

A theory is presented for predicting creep during fluctuating stress, based on an assumed creep-stress-time relation for simple static tension. The second part of the paper presents both static and dynamic tension creep test results for Plexiglas 1A, and theoretical and actual dynamic creep data are shown to be in approximate agreement.

"Pyrogallol as a Reducing Agent," Samuel H. Wein, *SPE J.*, 12, 1, 35 (Jan. 1956).

A review of the use of pyrogallol as the reducing agent in the process of metallizing a surface by chemical means. Factors involved in the process are discussed, together with advantages resulting from the use of pyrogallol.

Processing

"Paste Extrusion," W. B. Thompson, Jr., and R. E. Stabler, *Modern Plastics*, 33, 6, 115 (Feb. 1956).

The incorporation of an additive to finely-powdered Teflon resin permits the production of thin-wall tubing by the ram extrusion method.

"Developments and Experiences in Manufacture of Blown Film," P. Schen *Plastica*, 8, 8, 396; 8, 9, 452; 8, 10, 8, 11, 580. (Aug., Sept., Oct., and N 1955).

After giving some data on the prod tion of polyethylene in the United St and its use in the production of film, author, who is connected with the P Troester Maschinenfabrik, Hannover, tre the problem of equipment and installat in some detail. Various designs of truders and attachments (blow heads; flating, cooling and squeeze units; spre ing rolls and winding systems) are critic compared. Finally, attention also is gi to dimensional control and the raw ma rials employed. (In German).

"Surface Treatment of Molding," Fuzzard, *Brit. Plastics*, 28, 10, 413 and 11, 452 (Oct. and Nov. 1955).

Before discussing the different meth of treating plastic surfaces, the auth points out the importance of good moldi and tool finish. In this connection, briefly considers molding stresses, mai in polystyrene, and gives tables showi the effects of various solvents on plasti The methods and apparatus used in appl ing paints and lacquers, in hot stampi printing, and electro-deposition of chr mium and other metals also are discusse

"Manufacture of Reinforced Plast Tanks for Tank Trucks," M. T. Reis, *In Plastiques Mod.*, 7, 9, 21 (Nov. 1955).

The requirements of reinforced plasti for tanks are briefly reviewed. Calculation for the construction of a cylindrical tan with spherical bottom are given, followe by data on American methods, types o tank trucks made, and costs. (In French

Applications

"Preparation and Properties of Polyure thane Coatings," C. B. Reilly and Milto Orchin, *Ind. Eng. Chem.*, 48, 1, 59 (Ja 1956).

Data on the chemical preparation an physical properties of polyurethane coat ings which can be applied to leading edge of high-speed aircraft to protect the edge against rain erosion.

"Flexible Pipe from Synthetic Thermo plastic Materials," W. A. H. Eckhardt *Kunststoff-Rundschau*, 2, 10, 357 (Oct 1955).

The production of flexible thermoplastic pipe, mainly of polyethylene and PVC, are discussed with reference to current prac tice in England, Netherlands, and the United States. Special attention is given to corrugated and spiral tubing, and recent American procedure is described. (In Ger man).

Patent Digest

Materials

Polyalkylene Ether Glycol-Arylene Diisocyanate Elastomer Sponge and Process for Preparing Same. No. 2,726,219. Frederick B. Hill, Jr., New Castle, Del. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

An elastomeric sponge material is obtained by reacting 100-600 parts by weight of water with 100 parts by weight of the reaction product of a polyalkylene ether glycol having a molecular weight of 750-6,000 and a molar excess of an arylene diisocyanate.

Shaped Articles of Acrylonitrile Polymers. No. 2,726,220. Franklin F. Ogden, Dickinson, Tex. (to Monsanto Chemical Co., St. Louis, Mo.).

A shaped article comprising a cyanoethyl ether of cellulose and a polymer of acrylonitrile containing a major amount of acrylonitrile in the polymer molecule.

Dry Film Adhesive for Splicing Flexible Sheet Material. No. 2,726,222. P. V. Palmquist, New Canada Township, Minn., and J. D. Grove, St. Paul, Minn. (to Minnesota Mining & Mfg. Co., St. Paul, Minn.).

A temporarily thermoplastic, rapidly heat-curing adhesive composition in dry film form. The composition comprises a rubbery butadiene-acrylonitrile polymer; an oil-soluble, heat-advancing phenol-aldehyde resin; and a monomeric methylenequinone-liberating di-halomethyl alkyl phenol vulcanizing agent having the halomethyl groups ortho to the phenolic hydroxyl.

Modified Polyester Resins. No. 2,726,223. Pierre Alfred Talet, Paris, France (to Societe Nobel Francaise, Paris, France).

The process for the manufacture of contact resins from a mixture of a polyester of maleic acid and a polyhydric alcohol, and of a copolymerizable monoethylenic monomer. The resultant mixture is polymerized by the addition of benzoyl peroxide and mixing at a temperature of 70° C.

Copolymers of Vinyl Esters of Stabilized Rosin Acids and Vinyl Chloride and Process Therefor. No. 2,727,873. Walter S. Ropp, Wilmington, Del. (to Hercules Powder Co., Wilmington, Del.).

The rosin acid used in this reaction contains no more than 10% rosin acids with the carbon skeleton of abietic acid, and has two ethylenic double bonds per molecule.

Polyvinyl Acetate Plasticized with a Polyester. No. 2,726,225. Irving Pockel, Cambridge, Mass. (to Cambridge Industries Co., Cambridge, Mass.).

A composition comprising a polymer selected from the group consisting of polyvinyl acetate and polyvinyl acetate in which less than about 5% of the acetate groups have been hydrolyzed; and as plasticizer, a non-migrating, viscous liquid resinous polyester obtained by reacting diethylene glycol with an acid selected from the group consisting of terephthalic acid, isophthalic acid, and mixtures of the two acids and up to 35%, relative to the total amount of polyester, of a monobasic aromatic acid (benzoic acid or toluic acid).

Composition Comprising Polystyrene, Butadiene-Styrene Copolymer, and a Phosphite Ester. No. 2,726,226. Robert L. Werkheiser, Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

A composition comprising 100 parts of polystyrene; 1-20 parts of a butadiene-styrene copolymer in which the combined butadiene constitutes at least 50% by weight; and 0.05-1 part of an organic monohydric alcohol ester of phosphorous acid. The composition is prepared by dissolving the copolymer and ester in the styrene monomer, followed by polymerization of the monomer to an average molecular weight of at least 30,000.

Preparation of Plastic Condensable Alkyl Acrylate Polymers and Subsequent Elasto-Condensation Thereof. No. 2,726,230. Earl J. Carlson, Akron, O. (to B. F. Goodrich Co., New York, N. Y.).

The method comprises the preparation of a mixture of (1) an essentially saturated plastic polymer prepared by polymerizing in an acidic medium a monomeric mixture comprising an alkyl ester of acrylic acid containing from 1-12 carbon atoms in the alkyl group and an olefinically-unsaturated carboxylic acid, said polymerization is conducted with such proportions as to obtain a plastic interpolymer containing from 0.01-0.30 chemical equivalents by weight of combined COOH per 100 parts by weight of interpolymer; and (2) an amount of a polyvalent metal oxide at least equivalent to one-half said combined COOH. The mixture is heated at 125-140° F. until converted to an essentially elastic condition.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

Vinyl Chloride Resins Stabilized with Tin Mercaptides. No. 2,726,227. William E. Leistner and Olga H. Knoepke, Brooklyn, N. Y.

A plastic composition characterized by improved heat stability and non-blooming at temperatures as high as 350° F. The composition comprises a blend of PVC and a stabilizer selected from the tin mercaptide group having monovalent hydrocarbon radicals containing 1-18 carbon atoms (selected from the alkyls, aryls, furfuryl, and tetrahydrofurfuryl).

Olefin Conversion with Group 6a Metal Oxides and Reactive Metal Borohydrides. No. 2,728,758. Edmund Field, Chicago, and Morris Feller, Park Forest, Ill. (to Standard Oil Co., Chicago, Ill.).

Ethylene is contacted with a metal borohydride which reacts with water at polymerization temperature to produce hydrogen, and with a metal oxide of Group 6a in the Mendeleef Periodic Table. Temperature employed in the polymerization reaction is between 75 and 325° C.

Ethylene Polymerization Process. No. 2,728,755. Gert H. Weisemann, Hobart, Ind. (to Standard Oil Co., Chicago, Ill.).

This polymerization method employs diperoxy-dicarbonate ester as a catalyst. Ethylene is introduced continuously into the reaction chamber and, as a separate phase, an aqueous solution of a detergent is added in concentrations of 0.005-0.2% by weight. Portions are constantly withdrawn and subjected to heat interchange, thereby maintaining a uniform polymerization temperature. This material is then recycled, and polymerized mixtures are withdrawn for separation by centrifuge. Polyethylene is removed in the aqueous phase.

Di-Tert-Butyl Peroxydicarbonate for Ethylene Polymerization. No. 2,728,756. Herbert N. Friedlander, Homewood, Ill. (to Standard Oil Co., Chicago, Ill.).

Ethylene is contacted with 0.01-2% by weight of di-tert-butyl peroxydicarbonate at a temperature of 25-75° C., and at a pressure of 5,000-8,000 psi. High molecular weight polyethylenes are produced.

Improved Product Separation in Ethylene Polymerization Process. No. 2,728,753. Leonard W. Russum, Highland, Ind., Robert L. Hatch, Pittsfield, Mass., and Gert H. Weisemann, Hobart, Ind. (to Standard Oil Co., Chicago, Ill.).

Polymerization is effected in an ethylene phase under a pressure of 4,000-20,000 psi., and in the presence of a peroxy-type catalyst. A suspension of polymer in ethylene is withdrawn by pumping it through a discharge zone. This is accomplished by injecting a high pressure water jet downward into the suspension, which effects a three-phase mixture of polymer, ethylene, and water. The polymer is removed by centrifuging, and the ethylene is returned to the inlet side of the reactor.

Polymerization Process with Group V-A Metal and Metal Borohydride Catalyst. No. 2,728,757. Edmund Field, Chicago, and Morris Feller, Park Forest, Ill. (to Standard Oil Co., Chicago, Ill.).

An ethylene polymer, having a molecular weight of at least 300, is produced by contacting ethylene with an alkali metal borohydride and a group V-A metal oxide catalyst at a temperature between 75 and 325° C.

Colored Structures of Polyamides and Polyurethanes. No. 2,726,920. Wilhelm Federkiel, Frankenthal, Pfalz, and Helmut Pfitzner and Hans Baumann, Ludwigshafen, Germany (to Badische Anilin & Soda Fabrik Aktiengesellschaft, Ludwigshafen, Germany).

Both materials can be colored with a complex iron compound such as 1-nitroso-2-hydroxynaphthalene, 1-nitroso-2.6-dihydroxynaphthalene, 1-nitroso-2.7-dihydroxynaphthalene, and 1-nitroso-2-hydroxynaphthalene-6-sulfonamide.

Vinyl Chloride Polymers Plasticized with Dialkyl Esters of Alpha Aryl Glutaric Acids. No. 2,727,013. Raymond I. Longley, Jr., Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

The composition comprises approximately equal portions of homopolymers and copolymers of vinyl chloride, and a compound of the vinylidene chloride, vinyl acetate group. The resin is plasticized with a dialkyl ester of an alpha aryl glutaric acid, the alkyl groups containing 7-9 carbon atoms.

Continuous Ethylene Polymerization with Catalyst Regeneration. No. 2,728,754. Bernard L. Evering and Edwin F. Peters, Chicago, Ill. (to Standard Oil Co., Chicago, Ill.).

A solid catalyst containing at least 1% by weight of molybdenum oxide and a gamma-aluminum, titanium, or zirconium oxide is reacted with hydrogen at about 400-650° C., for a time sufficient to effect activation. Contact between ethylene and the catalyst is effected in the presence of a solvent and under polymerization conditions. The catalyst is separated from the ensuing stream, and partly regenerated by burning carbonaceous deposits therefrom with oxygen and recontacting with hydrogen at 400-650° C.

Phenol-Formaldehyde Resins for Foaming Compositions. No. 2,728,741. Eli Simon, Los Angeles, and Frank W. Thomas, Burbank, Calif. (to Lockheed Aircraft Corp., Burbank, Calif.).

The resins represent the condensation products of one mol phenol, 1-2.5 mols formaldehyde, from 2×10^{-4} to 1×10^{-4} mols barium hydroxide octahydrate, and from 1×10^{-2} to 2×10^{-2} mols sodium hydroxide. The hydroxides catalyze the reaction.

Compositions Containing a Polyhydric Alcohol and Glycidyl Ethers. No. 2,728,744. Clayton A. May, Oakland, and Edward C. Shokal, Walnut Creek, Calif. (to Shell Development Co., Emeryville, Calif.).

A glycidyl ether having a 1,2-epoxy equivalency greater than 1.0 and a hydroxyl value of less than 0.12 is admixed with a neutral aliphatic, polyhydric alcohol. An amine curing agent is added, and the mixture heated to produce a resin.

Polyester Resins. No. 2,728,747. David Aelony and Malcolm M. Renfrew, Minneapolis, Minn. (to General Mills, Inc., Minneapolis, Minn.).

P-hydroxybenzoic acid is heated in the presence of triphenyl phosphite until the reaction product has a softening temperature in the range of 150-350° C.

Long Chain Acrylic Type Ester/Aminostyrene Copolymers. No. 2,728,751. Willard E. Catlin, Wilmington, Del., and Benjamin W. Howk, West Chester, Pa. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The compound is a copolymer of lauryl methacrylate with p-aminostyrene, and contains 0.1-4.5% by weight of primary amino nitrogen.

Thermoset Sulfonamide Polymers. No. 2,727,877. Harold F. Park, East Longmeadow, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

An organic compound containing an amino group is reacted with formaldehyde to form a methylol derivative which, in turn, is reacted with a vinyl sulfonamide polymer to form substantially-insoluble reaction products.

Polyblends. No. 2,727,878. Richard L. Ballman, Northampton, and John M. Chamberlin, Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

A polyblend molding powder is prepared by mixing an aqueous latex of a styrene homopolymer, which has a Staudinger molecular weight of 40,000-90,000, with an aqueous latex of a styrene-butadiene copolymer. The ratio should be approximately 95-99.5 to 0.5-5 when dried. The blend is malaxated at elevated temperatures, and the particle size reduced. The resulting copolymer contains 40-80% butadiene by weight, and has a Mooney viscosity of 50-100.

Modified Alkyd Resins. No. 2,727,870. Ellington M. Beavers and Richard S. Urban, Philadelphia, Pa. (to Rohm & Haas Co., Philadelphia, Pa.).

Styrene, methyl methacrylate, and a preformed alkyd resin are reacted at a temperature above 100° C., and in the presence of a polymerization catalyst. The alkyd is obtained by reacting phthalic anhydride, a polyhydric alcohol, and dehydrated castor oil.

Process of Mass Polymerization in Vertical Unmixed Strata. No. 2,727,884. Donald L. McDonald, Coleman, and Kenneth E. Coulter, Midland, Mich., and John Lloyd McCurdy, Torrance, Calif. (to Dow Chemical Co., Midland, Mich.).

Polymerizable vinylidene compounds in liquid form are fed into a vertical, elongated polymerization zone. The fluid mass becomes more viscous as the material is progressively polymerized, and is gently stirred as it moves along transverse to the longitudinal axis of the column. This causes the mass to stratify, with each successive layer containing increasing amounts of the polymer. Non-turbulent stirring prevents channeling, but does not mix the layers.

Resinous Copolymer of Vinyl Acetate and a Vinyl Ester of a Hydrogenated or Dehydrogenated Rosin Acid. No. 2,727,871. Walter S. Ropp, Wilmington, Del. (to Hercules Powder Co., Wilmington, Del.).

The rosin acid chosen for the reaction is chemically stable, and contains not more than 10% rosin acids with the carbon skeleton of abietic acid and having two ethylenic double bonds per molecule.

Processing

Method of Coating Sheet Metal with Plastic. No. 2,728,703. Conleth E. Kiernan, Naugatuck, and William K. Fischer, Woodbury, Conn. (to United States Rubber Co., New York, N. Y.).

A uniform vinyl film can be continuously laid on a sheet of metal, using a thermoplastic adhesive. This adhesive consists essentially of a vinyl chloride-vinyl acetate copolymer modified by a small amount of maleic anhydride, butyl methacrylate in polymer form, and isobutyl methacrylate. The metal is rapidly advanced through a preheating zone, and coated with the adhesive which also has been preheated to a temperature of 325° F. The film is then applied, using a rotating pressure roll device which is capable of exerting a pressure of approximately 50 psi.

Cementable Polytetrafluoroethylene and the Method of Making Articles Thereof Cementable. No. 2,728,698. Merritt Allen Rudner, Haddonfield, N. J. (to United States Gasket Co., Camden, N. J.).

The cementable article comprises a dense, non-porous body of polytetrafluoroethylene and an integral sheet of separately-preformed, porous, absorbable material.

Anchoring Process for Moistureproof Heat-Sealable Regenerated Cellulose Film. No. 2,728,688. Eric Wellisch, East Haven, Conn. (to Olin Mathieson Chemical Corp., New York, N. Y.).

An aqueous dispersion of a copolymer, heat-sealable top-coat can be anchored to a base film of regenerated cellulose by reacting a cationic, wet-strength urea-formaldehyde resin with glycerol at elevated temperatures. This effects dehydration and softening of the resin. A water solution of this material is applied over the film and dried, before adding the top-coat.

Domestic Production and Sales of Plastics and Resin Material, November and December, 1955

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of March and April, 1955. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

Sales took a rather sharp drop in December, mainly in molding materials. This is probably due to the Christmas lag, toys and other molded items having been manufactured earlier. Grand totals were however, considerably higher than last year's.

	November		December	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,374,123	1,673,413	1,756,841	1,534,076
Sheets, 0.003 gage and over	1,511,326	1,428,203	1,687,507	1,330,335
All other sheets, rods, and tubes	609,915	648,746	596,242	595,081
Molding and extrusion materials	8,394,060	8,730,489	7,704,943	7,509,299
Nitrocellulose sheets, rods, and tubes	451,304	484,404	427,691	463,960
Other cellulose plastics	642,969	616,466	432,564	392,715
TOTAL	12,983,697	13,581,721	12,605,788	11,825,466
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	19,127,373	17,979,534	18,766,381	16,121,640
Bonding and adhesive resins for—				
Laminating (except plywood)	6,140,152	4,708,612	5,989,404	4,099,529
Coated and bonded abrasives	1,364,209	1,547,468	1,480,977	1,468,008
Friction materials (brake linings, clutch facings, and similar materials)	2,211,229	1,978,137	2,254,040	1,682,532
Thermal insulation (fiber glass, rock wool)	5,124,975	5,308,691	5,286,628	4,903,227
Plywood	3,992,141	3,242,251	3,960,805	3,286,398
All other bonding and adhesive uses	3,033,871	3,021,443	2,493,996	2,384,381
Protective-coating resins, unmodified and modified except by rosin	2,492,856	2,187,316	2,127,490	1,902,686
Resins for all other uses	3,670,563	2,893,882	2,811,800	2,349,072
TOTAL	47,157,369	42,867,334	45,171,521	38,197,473
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	4,049,269	3,975,455	3,909,147	3,989,724
Paper-treating and paper-coating resins	2,067,965	1,618,217	2,006,878	1,944,964
Bonding and adhesive resins for—				
Plywood	8,651,944	8,090,290	8,576,901	7,475,691
All other bonding and adhesive uses, including laminating	2,417,609	2,365,180	2,056,502	2,092,808
Protective-coating resins, straight and modified	3,522,960	2,837,003	3,150,606	2,241,817
Resins for all other uses, including molding	8,010,403	7,444,906	7,656,699	6,050,775
TOTAL	28,720,150	26,331,051	27,356,733	23,795,779
Styrene Resins:				
Molding materials[1]	40,081,328	36,256,231	39,427,912	30,306,203
Protective-coating resins, straight and modified	9,288,551	7,951,862	9,147,569	7,797,510
Resins for all other uses	8,190,607	8,096,569	8,005,788	7,314,099
TOTAL	57,560,486	52,304,662	56,581,269	45,417,812
Vinyl and Vinyl Chloride Resins:[2]				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		6,855,426		6,273,264
Sheeting (resin content)		4,771,308		4,584,814
Molding and extrusion (resin content)		18,223,569		16,682,241
Textile and paper treating and coating (resin content)[3]		6,271,048		6,088,687
Flooring (resin content)		4,944,752		4,214,077
Protective coatings (resin content)		2,146,625		1,979,948
All other uses (resin content)		6,817,738		5,457,546
All other vinyl resins for—				
Adhesives (resin content)		2,944,785		2,190,142
All other uses (resin content)		9,830,814		10,087,429
TOTAL	62,199,548	62,806,065	61,285,034	57,558,148
Coumarone-Indene and Petroleum Polymer Resins	23,211,850	22,835,355	19,891,828	19,192,119
Polyester Resins:				
For reinforced plastics	4,080,086	3,963,140	5,152,630	4,075,703
For all other uses	361,717	397,204	399,722	197,212
TOTAL	4,441,803	4,360,344	5,552,352	4,272,915
Polyethylene Resins	40,911,329	35,630,762	40,609,609	34,448,193
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1] [4]	4,928,198	4,449,268	4,762,741	3,858,790
Protective-coating resins[5]	341,261	215,656	262,911	234,343
Resins for all other uses[6]	7,635,285	7,355,858	7,322,356	7,173,803
TOTAL	12,904,744	12,020,782	12,348,008	11,266,936
GRAND TOTALS	290,090,976	272,738,076	281,402,142	245,974,841

[1] Includes fillers, plasticizers, and extenders.
[2] Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3] Includes data for spreader and calendering-type resins.
[4] Includes data for acrylic, nylon, silicone, and other molding materials.
[5] Includes data for epichlorohydrin, acrylic, polyester, silicone, and other protective-coating resins.
[6] Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
SOURCE: United States Tariff Commission, Chemical Division.

CALENDAR of COMING EVENTS

April 16
SPE Southern Section, Mammy's Shanty, Atlanta, Ga.

April 18
SPE New York Section, Gotham Hotel, New York, N. Y.

April 19
SPE Eastern New England Section, Hotel Beaconsfield, Brookline, Mass.

April 19
SPE Ontario Section, St. Regis Hotel, Toronto, Ont.

April 19
SPI Southern California Chapter, Annual Business Meeting, Scully's Restaurant, Los Angeles, Calif.

April 25-26
SPI Midwest Plastics Conference, French Lick-Sheraton Hotel, French Lick, Ind.

May 2
SPE Western New England Section, Bradley Field, Windsor Locks, Conn.

May 3
SPE Southern California Section, Scully's Restaurant, Los Angeles, Calif.

May 9
SPE Newark Section, Military Park Hotel, Newark, N. J.

May 14
SPE Cleveland-Akron Section, Spanish Tavern, Brecksville, O.

May 14-17
Design Engineering Show, Philadelphia, Pa.

May 16
SPE New York Section, Gotham Hotel, New York City

May 21
SPE Southern Section, Mammy's Shanty, Atlanta, Ga.

May 21
SPE Upper Midwest Section's Plastic Fair

June 11-15
SPI Seventh National Plastics Exposition & Technical Conference, Coliseum, New York, N. Y.

June 26
SPI Plastic Structures Division Conference, Hotel Roosevelt, New York City

INDEX TO ADVERTISERS

APRIL, 1956

Allied Chemical & Dye Co. ..... Second Cover
Automatic Molding Machine Co. 206
Baker Castor Oil Co. 263
Barber-Colman Co. 249
Godfrey L. Cabot, Inc., Plastics Chemical Division 214
Carbide & Carbon Chemicals Co. ..... Back Cover
Ciba Company, Inc., Plastics Division 208
Coast Manufacturing and Supply Co. 212
Detroit Mold Engineering Co. 219
E. I. du Pont de Nemours & Co., Inc. 218
Emery Industries, Inc. 204
General Tire & Rubber Company, Chemical Division ..... Third Cover
B. F. Goodrich Chemical Company 216
Goodyear Tire & Rubber Co., Chemical Division 203
Hercules Powder Company, Cellulose Products Department 209-210
Metal & Thermit Corp. 207
Monsanto Chemical Company 213
Metasap Chemical Company 220
Rubber Corporation of America 260
Sindar Corporation 259
Society of the Plastics Industry 251
R. T. Vanderbilt Co., Inc. 261
Wilner Wood Products Company 268

Industrial News Briefs
(Cont'd. from pg. 255)

Durable Formed Products, Inc., New York, has announced the installation of additional manufacturing equipment. Over 22,000 square feet of floor space will be devoted to thermoplastic sheet forming and fabricating.

Alsynite (Australia) Pty., Ltd., has been formed jointly by Australian Consolidated Industries, Ltd., and W. J. Manufacturing Co., Ltd., to make and distribute Alsynite fiber-glass-reinforced products under agreement with the Alsynite Co. of America. A new factory has been set up at Manly Vale. W. J. Mfg. is to supervise administration and manufacturing, while A.C.I. will handle distribution in Australia, New Zealand, and, later, in the South Pacific area and the Near East.

Witco Chemical Co., New York, N. Y., moved its San Francisco, Calif., office to new and more modern quarters at 80 Stonestown St. The office is under the direction of J. L. Mattson, district manager.

E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., has reduced prices for Hylene organic isocyanates by 15¢ per pound. These chemicals, in combination with other compounds, form rubber-like or plastic materials having wide use potentials in building, transportation, upholstery, and insulation. The new prices per pound, for standard (500 pounds net) are: Hylene T, $1.15; Hylene TM, $1.05; and Hylene TM-65, $1.05.

Positions Open

Display Rates $10.00 per Inch.

FACTORY MANAGER NEEDED

Present manager to be promoted. Replacement required by a division of a nationally known corporation. M.E. or I.E. with experience in production, production planning, cost control estimating, scheduling, inventory control, shipping and receiving. Proven leadership, organizational, supervisory and training ability. Knowledge of reinforced plastics, adhesives and plastic panel production desirable but not essential. Liberal company benefits. Submit resume including present salary earned. Reply to Box No. 54.

PLASTICS TECHNOLOGY
386 Fourth Ave., New York 16, N. Y.

Current Market Prices

This listing is as comprehensive and up-to-date as possible. The full listing will appear quarterly, while intervening issues will carry a briefer tabulation of price changes and additions.

Companies whose products do not appear are invited to submit price data for inclusion in the listing. All suppliers are requested to submit product additions and price changes promptly as they occur, in order to make this listing of maximum value to our readers.

Prices, in general, are f.o.b. works. Ranges indicate quantity or grade variations. No guarantee of these prices is made, and spot prices should be obtained from the individual suppliers.

—The Editor

Adhesives

Ampcodex Adhesive	gt.	$2.75 /	$3.50
Bakelite BC—17613	lb.	.54	.84
BCU-40	lb.	.18	.48
BR-11938	lb.	.285	.585
Bonding resins, abrasives	lb.	.20 /	.915
Brake linings	lb.	.215	.6275
Foundry resins	lb.	.2075	.395
Heat Insul. resins	lb.	.1425	.37
CD Cement Nos. 200, 201, 202, 203, 204	gt.	$0.94 /	$1.50
PS-7	gt.	2.12 /	2.90
Epon Adhesive VI, VIII	lb.	3.08 /	3.30
IX	lb.	4.25 /	4.50
Epoxy Adhesive A-1, A-3			
A-4	gt.	4.45 /	6.90
A-2, A-5	gt.	5.60 /	8.00
A-6	gt.	5.80 /	8.00
C-1, C-2, C-3, C-9	gt.	5.60 /	8.00
C-4, C-7	gt.	3.69 /	5.30
Flexible Resin No. 1	gt.	4.45 /	6.90
G-E 12316	lb.	.30 /	.39
12333	lb.	.225 /	.385
Melmac 401	lb.	.45	
421	lb.	.45 /	.47
Melurac 300, 302	lb.	.25 /	.29
301	lb.	.28 /	.33
Metlbond 2002-14	gt.	1.84 /	5.00
4021 Type I	sq. ft.	1.43	
Type II	gt.	1.29 /	3.20
Type III	gt.	1.49 /	3.50
Plaskon Phenolic Bonding Resin	lb.	.16 /	.21
Urea Adhesive 530-11L	lb.	.1875/	.2175
Liquid Adhesive, 2L Types	lb.	.105 /	.115
WR Types	lb.	.0675/	.125
Spray Dried Adhesives	lb.	.18 /	.29
Plastic Cement	gal.	2.25 /	2.70
Plobond 20	gal.	4.50 /	7.00
130	gal.	5.25 /	8.00
Polyester Foam Cement			
PC-232	gal.	2.40 /	2.90
Schenectady SP-7401	lb.	.29 /	.31
Schwartz Vinyl Cement	gt.	1.24 /	1.50
Synvaren PLS-A	lb.	.56 /	.595
Synvarol WR-513	lb.	.1875/	.1225
WR-515	lb.	.0825/	.1175
Styrofoam Adhesive #5	gal.	3.75 /	4.75
Thixons	gal.	3.30 /	9.00
Urac 110	lb.	.205 /	.225
115	lb.	.24 /	.26
180	lb.	.095 /	.12
185	lb.	.1625/	.2175
186	lb.	.0875/	.1125
191	lb.	.07	

Catalysts

Advasol	lb.	.4375/	.5375
Aritemp Curing Agent 105	lb.	2.00 /	2.25
Bakelite BH-17618	lb.	.33 /	.63
BHU-53	lb.	.15 /	.45
ERL series	lb.	.67 /	1.195
Cadet benzoyl peroxide, granules	lb.	.98 /	2.00
Paste	lb.	.95 /	2.25
Powder	lb.	1.50 /	2.37
Dichlorobenzoyl peroxide	lb.	3.00 /	4.25
Lauroyl peroxide	lb.	1.90 /	3.50
Methyl ethyl ketone peroxide	lb.	1.85 /	4.00
Catalyst 57	lb.	.12	
196	lb.	.10	
C-110, -180, -180-S, C-110-S, WF-100, -101	lb.	.12	
Celanese accelerators D & E	lb.	.43 /	.50
Benzol peroxide paste	lb.	2.00	
Catalyst MC-1	lb.	2.25 /	2.50
Epon Curing Agent BF$_3$-400	lb.	4.00 /	4.50
C-111	lb.	.6225/	1.10
D	lb.	3.33 /	4.75
T	lb.	.80 /	1.11
U	lb.	.86 /	1.02
Z	lb.	1.265 /	1.56
Furane H-736-A	lb.	1.30 /	2.00
Hardener 157	lb.	1.00 /	1.15
175, 179, 191	lb.	.50 /	.65
181, 184, 185, 185-S, M-325	lb.	.12	
342	lb.	1.40 /	1.55
H C Promoter 6%	lb.	.5275/	.6275
12%	lb.	.9025/	1.0025
Het anhydride	lb.	.55	
HN 551	lb.	.95 /	1.40
901	lb.	.36 /	.80
951 Ciba	lb.	.82 /	1.32
951 Furane	lb.	1.30 /	2.00
IC activators		3.00	
Inhibitor	lb.	.98	
Melurac 255, 259	lb.	.35	
Modifier CB-110,WF-61	lb.	.15	
P-27	gal.	10.00	
Plaskon Hardeners, Liquid	lb.	.07	
Powdered	lb.	.10 /	.46
Spray dried	lb.	.10 /	.25
Promoter D-2	lb.	1.60 /	2.00
Quick-Set Accelerator 804	gal.	9.80	
Rezolin epoxy hardeners	lb.	1.14 /	2.50
SA Hardener	lb.	.10	
Soligen	lb.	.4825/	.5825

Coating Resins

Bakelite Phenolics	lb.	.28 /	.64
Styrene emulsions	lb.	.1375/	.31
Vinyl acetates	lb.	.295 /	.66
Solutions	gal.	5.10	
Alcohols	gal.	2.27 /	2.76
Butyral resins	lb.	1.04 /	1.24
Chlorides	lb.	.41 /	.61
Chloride-acetates	lb.	.38 /	.66
Modified	lb.	.44 /	.72
Celanese PVA emulsions, homopolymers	lb.	.17 /	.26
Copolymers	lb.	.19 /	.28
Chemigum latices	lb.	.46 /	.60
Dylex K-500, -600, -700, -900	lb.	.30 /	.46
G-E 13110	lb.	.30 /	.39
G.M I. Polyamide 100	lb.	.51 /	.64
115	lb.	.54 /	.77
Kel-F Dispersion (dry wt.)	lb.	12.00	
Ladcote FHHF-4010, FVHF-4010	lb	.3575/	.4075
Plaskon Alkyds	lb.	.1075/	.3375
Modified	lb.	.15 /	.2625
Ester Gums	lb.	.1425/	.2475
Maleics	lb.	.1825/	.275
Melamines	lb.	.195 /	.435
Phenolics	lb.	.3925/	.475
Modified	lb.	.1825/	.29
Phenolic Laminating Varnishes	lb.	.165 /	.27
Silicone Alkyds	lb.	1.10 /	2.40
Ureas	lb.	.195 /	.435
Pliolite latices	lb.	.30 /	.39
Pliolite N R	lb.	.93 /	1.22
S-3	lb.	.42 /	.44
S-5	lb.	.49 /	.51
Milled	lb.	.54 /	.56
S-7	lb.	.88 /	1.01
Polyfluoron liquid dispersions	lb.	2.65 /	3.85
Paste dispersions	lb.	4.20 /	4.40
Primer 140	gt.	7.88 /	8.25
Schenectady Alkyds SA Type	lb.	.3575/	.38
SE Type	lb.	.3675/	1.435
SEA Type	lb.	.3575/	.38
Styrenated	lb.	.22 /	.2625
Maleics	lb.	.1725/	.23
Phenolics	lb.	.2325/	.53
Modified	lb.	.1825/	.275
Schwartz AT-25	gt.	.63 /	1.00
BF 40	gal.	3.80 /	3.95
Synvaren 631	lb.	.17 /	.25
PLS-R	lb.	.175 /	.26
Synvarite RRLD	lb.	.40 /	.46
Versamid 100	lb.	.51 /	.69
115	lb.	.64 /	.82

Colors

Acheson 0100 Series Paste Dispersions:			
Blacks	lb.	.50 /	.81
Blues	lb.	.55 /	2.178
Green	lb.	2.51 /	2.69
Orange	lb.	.67 /	.83
Reds	lb.	1.08 /	1.34
White	lb.	.52 /	.70
Yellows	lb.	.57 /	.75
Advabrite M-10	lb.	2.25 /	2.40
Advance Brightener			
M D A C	lb.	12.00 /	15.00
Akron Chemical Colors:			
Dry blends, reds	lb.	1.08 /	1.23
Yellows	lb.	.58 /	.88
Organic colors, blues	lb.	.75 /	3.60
Greens	lb.	1.35 /	3.95
Reds	lb.	1.10 /	4.40
Yellows	lb.	2.00 /	5.00
Pastes, blues	lb.	1.25 /	1.58
Greens	lb.	1.85 /	1.90
Reds	lb.	1.10 /	1.40
White	lb.	.55 /	.60
Yellows	lb.	1.70 /	1.75
Aquablak No. 1	lb.	.1925/	.1975
B	lb.	.0975/	.1025
G, K	lb.	.12 /	.125
H	lb.	.20 /	.205
L	lb.	.14 /	.145
M	lb.	.105 /	.11
S	lb.	.1175/	.1225
U	lb.	.225 /	.23
X	lb.	.11 /	.115
Cadmolith Reds	lb.	1.72 /	2.20
Yellows	lb.	1.12 /	1.20
Claremont 4000-series Pastes			
Blacks	lb.	.82 /	1.01
Blue	lb.	.80	
Browns	lb.	.65 /	2.30
Greens	lb.	.80 /	2.15
Orange	lb.	1.58	
Red	lb.	4.15 /	4.80
Silver	lb.	1.02	
White	lb.	.695	
Yellows	lb.	.65 /	2.87
D-Series pastes,			
Blacks	lb.	.47 /	.68
Blues	lb.	.62 /	1.83
Golds	lb.	2.31 /	2.49
Green	lb.	1.86 /	1.88
Oranges	lb.	.70 /	3.65
Reds	lb.	1.18 /	2.57
Silver	lb.	.89 /	.91
Whites	lb.	.45 /	.60
Yellows	lb.	.83 /	1.68
K-Series pastes,			
Blacks	lb.	.88 /	.71
Blues	lb.	.91 /	1.40
Browns	lb.	.83	
Greens	lb.	.94 /	1.41
Metallics	lb.	.91 /	2.47
Orange	lb.	.80 /	3.84
Reds	lb.	1.03 /	5.07
Violet	lb.	2.30	
Whites	lb.	.50 /	.60
Yellows	lb.	.73 /	3.02
Cololdex No. 3	lb.	.24	
Columbian Carbon bone blacks:			
Ivo No. 1	lb.	.1975/	.2075
3	lb.	.1875/	.1975
4	lb.	.16 /	.17
100	lb.	.2075/	.2175
359	lb.	.2025/	.2125
457	lb.	.1925/	.2025
Columbian Carbon colloidal dispersions:			
Concetateblak CQ-21	lb.	.875 /	.90
CoblacDD Sol, Industrial	lb.	.70 /	.725
Coethioblak CK	lb.	1.00 /	1.025
Coresinblak No. 3	lb.	.76 /	.785
Costyreneblak CJ-21	lb.	.5425/	.5675
Covarnishblak AR	lb.	.60 /	.625
BJ	lb.	.50 /	.525
BK	lb.	.53 /	.555
Covinylblak BA	lb.	.95 /	.975
BD	lb.	.97 /	.995
BF	lb.	.70 /	.725
BH	lb.	.66 /	.685
BL	lb.	.82 /	.845
BM	lb.	.77 /	.795
CA-18	lb.	1.0725/	1.0975
Cowaxblak BV-25	lb.	.515 /	.54
CH-18	lb.	.5875/	.6125
CM-83	lb.	.485 /	.51

Cyanamid dyes, calcosines	lb.	.81 /	5.57
Nigrosines and indulines	lb.	.59 /	.97
Oils	lb.	.62 /	7.29
Inorganic pigments			
Blues, cobalt	lb.	.305 /	.35
Iron	lb.	.50 /	.52
Ultramarine	lb.	.165 /	.19
Greens, chrome	lb.	.39 /	.45
Oranges, chrome	lb.	.335	
Molybdate	lb.	.405	
Yellows, chrome	lb.	.335	
Zinc	lb.	.275	
Organic pigments			
Blues, alkali, dry	lb.	2.20	
Flushed	lb.	1.17 /	1.25
Molybdated & tungstated	lb.	2.60 /	6.10
Phthalocyanine	lb.	.90 /	3.60
Cadmium lithopones, reds	lb.	2.29 /	3.77
Yellows	lb.	1.12 /	1.15
Greens, mol. & tung	lb.	3.20 /	6.40
Phthalocyanine	lb.	1.71 /	3.95
Oranges	lb.	.70 /	3.00
Reds, bon	lb.	1.50 /	2.00
Chlorinated	lb.	1.20	
Lithols	lb.	.90 /	.95
Naphthols	lb.	.80 /	3.60
Paras	lb.	1.10	
Rhodamines	lb.	4.45 /	6.40
Toluidines	lb.	1.62 /	1.65
Violets	lb.	.75 /	4.15
Yellows	lb.	.62 /	2.35
DC Globak	lb.	.77 /	.795
DCY Coblac	lb.	.83 /	.855
Ferro blues, browns, greens	lb.	.90 /	2.90
Reds	lb.	2.93 /	4.75
Yellows	lb.	.91 /	2.90
Hiblak AE	lb.	.095 /	.10
Interchemical IC Series			
Black	lb.	.56	
Blues	lb.	.75 /	2.10
Browns	lb.	.64 /	.69
Greens	lb.	.90 /	.99
Oranges	lb.	.78 /	.89
Reds	lb.	1.16 /	2.50
White	lb.	.70	
Yellows	lb.	.95 /	1.65
Kentucky inorganics, orange	lb.	.44 /	.64
Yellows	lb.	.31 /	.66
Organics, blues	lb.	3.00 /	4.15
Greens	lb.	3.50 /	4.60
Purple	lb.	1.85 /	2.05
Reds	lb.	1.95 /	3.85
Kriegt-O-Dip W Types	gl.	2.63 /	7.80
A Types	gl.	1.52 /	2.25
Laminac color pastes	lb.	.76 /	1.90
Mapico colors, black	lb.	.1425/	.145
Browns	lb.	.1525/	.155
Reds	lb.	.1375/	.14
Tans	lb.	.2275/	.23
Yellows	lb.	.115 /	.1225
Mearlmaid Pearls	lb.	14.00 /	25.00
Nacromer Pearls, Series C	lb.	2.15 /	2.25
Series W	lb.	1.50 /	1.60
Pearl Essence, nat	lb.	15.00 /	30.00
Synthetic #100	lb.	1.95	
#300	lb.	1.45	
#600, #900	lb.	2.15 /	2.45
Plastic Color, blacks	unit	.75 /	1.40
Blues	unit	.65 /	1.10
Brown	unit	1.20	
Greens	unit	.65 /	1.00
Reds	unit	.65 /	2.50
Whites	unit	.80 /	1.30
Yellows	unit	1.15 /	1.55
Pliolite S-5 bases with pigment			
Blacks	lb.	.44 /	.49
Blues	lb.	.62 /	1.48
Greens	lb.	.54 /	.58
Oranges	lb.	.61 /	.63
Reds	lb.	.31 /	1.20
Whites	lb.	.42 /	.44
Yellows	lb.	.43 /	.45
PMS polyester colors	lb.	.85 /	2.85
Polystyrene colors	lb.	.65 /	4.30
Polysupra polyethylene blues	lb.	.65 /	5.60
Blacks	lb.	.50 /	.80
Browns	lb.	1.48 /	3.30
Greens	lb.	1.82 /	3.55
Ivory	lb.	.65 /	1.00
Purples	lb.	2.10 /	3.30
Reds	lb.	.70 /	6.30
Silver	lb.	1.50 /	2.95
White	lb.	.60 /	.85
Yellow	lb.	1.45 /	4.25
Polystyrene blues	lb.	.50 /	9.20
Blacks	lb.	.50 /	5.30
Browns	lb.	.95 /	2.55
Greens	lb.	.35 /	7.40
Ivory	lb.	.85 /	1.20
Reds	lb.	.35 /	6.40
White	lb.	.60 /	1.05
Yellows	lb.	1.45 /	3.95
R-B-H Plastic Powders:			
Blacks	lb.	.71 /	.79
Blues, iron	lb.	.875	
Phthalocyanines	lb.	2.73	
Browns	lb.	.61 /	.87
Greens, chrome	lb.	.855	
Phthalocyanines	lb.	2.34	
Orange	lb.	.87	
Purple	lb.	3.00	
Red	lb.	1.93	
Whites	lb.	.71 /	.74
Yellow	lb.	.81	

Resin Plasticizer Pastes:			
Blacks	lb.	.505 /	.65
Blue	lb.	1.59	
Green	lb.	1.58	
Orange	lb.	.665	
Reds	lb.	1.15 /	2.24
White	lb.	.50	
Yellows, cadmium	lb.	1.20	
Chrome	lb.	.545	
Vinyl Extrusion Chips:			
Blacks	lb.	.975 /	1.04
Blues, iron	lb.	.90 /	1.08
Phthalocyanine	lb.	2.50	
Brown	lb.	.86	
Green, chrome	lb.	.96	
Phthalocyanine	lb.	2.51	
Oranges	lb.	.875 /	.92
Purple	lb.	3.41	
Reds	lb.	1.38 /	2.02
White	lb.	.78	
Yellow	lb.	.845	
R-C blacks	lb.	5.50 /	21.30
Browns	lb.	4.375 /	15.75
Reds	lb.	.28 /	15.05
Yellows	lb.	3.60 /	14.05
Res-N-Dye (dry wt.)	lb.	7.50	
Saran colors	lb.	.59 /	1.80
Sherwin-Williams Dispersed Colors	lb.	.55 /	1.97
Inorganic colors, oranges, yellows	lb.	.32 /	.45
Organic colors, blues	lb.	.90 /	3.60
Greens	lb.	1.35 /	3.95
Reds	lb.	.85 /	4.40
Yellows	lb.	.55 /	1.97
Stan-Tones, blues, cadmium dry	lb.	1.95 /	2.15
Dry	lb.	.90 /	5.00
GPE	lb.	1.90 /	2.57
MBS	lb.	1.55 /	4.62
PC	lb.	1.80 /	1.92
Brown, GPE	lb.	3.00	
Greens, dry	lb.	.82 /	3.95
GPE	lb.	3.00 /	4.57
MBS	lb.	1.55 /	3.42
PC	lb.	2.20 /	2.25
Maroon, dry	lb.	5.50	
Oranges, cadmium dry	lb.	2.23 /	5.05
Paste	lb.	2.65 /	3.65
GPE	lb.	1.20 /	4.42
MBS	lb.	2.75 /	2.82
PC	lb.	.75 /	3.25
Reds, cadmium dry	lb.	2.49 /	6.15
Paste	lb.	3.35 /	3.95
Dry	lb.	.85 /	4.60
GPE	lb.	1.65 /	3.00
MBS	lb.	1.00 /	3.60
PC	lb.	1.10 /	3.57
Yellows, cadmium dry	lb.	2.80 /	3.18
Paste		1.63 /	2.19
Dry	lb.	.62 /	2.35
GPE	lb.	2.00 /	4.57
MBS	lb.	1.30 /	2.27
PC	lb.	1.65 /	3.57
Unitane O	lb.	.245 /	.255
OR	lb.	.265 /	.275
Vansul Organic Drys			
Blues	lb.	3.45 /	3.60
Greens	lb.	1.35 /	3.95
Oranges	lb.	2.21 /	3.00
Reds	lb.	.90 /	4.40
Yellows	lb.	2.00 /	2.25
VAP Dry Dispersions			
Black	lb.	1.00	
Blues	lb.	2.90 /	3.60
Greens	lb.	3.20 /	4.05
Oranges	lb.	1.45 /	2.55
Reds	lb.	1.70 /	4.45
Yellows	lb.	1.35 /	2.55
VP-Series Pastes			
Black	lb.	.70	
Blue	lb.	1.65	
Brown	lb.	1.55	
Green	lb.	2.05	
Oranges	lb.	.80 /	2.30
Reds	lb.	1.15 /	2.55
White	lb.	.47 /	.65
Yellows	lb.	.60 /	1.65
VPE-Series Pastes			
Black	lb.	.90	
Blue	lb.	1.85	
Green	lb.	2.10	
Orange	lb.	1.00	
Reds	lb.	1.45 /	2.30
White	lb.	.90	
Yellows	lb.	1.60 /	2.00
VV Chips			
Blacks	lb.	.90 /	1.30
Blues	lb.	1.00 /	2.25
Brown	lb.	1.60	
Greens	lb.	.90 /	2.45
Oranges	lb.	1.00 /	2.15
Reds	lb.	1.40 /	2.70
White	lb.	.65	
Yellows	lb.	.85 /	1.80
Vinylized colors, blacks, whites	lb.	.755	
Blues	lb.	1.16 /	1.18
Golds	lb.	1.51 /	1.57
Green	lb.	1.45	
Metallic	lb.	1.15	
Orange	lb.	.83	
Reds	lb.	1.15 /	2.27
Yellows	lb.	.76 /	1.09
Violite 199, green	lb.	2.95	
200, yellow	lb.	3.75	
PL 3-60, blue	lb.	3.25	
18-70, blue	lb.	3.70	
Witcoblaks	lb.	.075 /	
Zopaque, anatase	lb.	.225 /	
Rutile	lb.	.245 /	

Dispersing Agents

Daxads	lb.	.08 /	

Fillers

Advaresin CXF	lb.	.49 /	
KF	lb.	.38 /	
A. F. D.	ton	26.50 /	60.00
Aluminum Flake	ton	23.50 /	30.00
ASP 400	ton	24.00	
ASP 1300	ton	70.00	
Atomite	ton	32.50	
Burgess Iceburg Pigment	ton	50.00	
Pigment No. 30	ton	37.00	
Cab-o-sil	lb.	.68 /	
Calcene NC	lb.	.036 /	
TM	lb.	.0375/	
Camel—CARB	ton	12.00	
—TEX	ton	20.00	
—WITE	ton	32.50	
Cotton flocks	lb.	.12 /	
Crown Clay	ton	14.00	
Dixie Clay	ton	14.00 /	34.50
Duramite	ton	20.00	
Edgar ASP 200	ton	45.00	
900	ton	18.50	
1300	ton	80.00	
Harwick fillers:			
Clays, Champion	ton	14.00	
Harwick	ton	14.50 /	57.00
Flock, white	lb.	.11 /	
Colored	lb.	.11 /	
Magnesium carbonate	lb.	.105 /	
Magnesia, tech	lb.	.105 /	
Mica, Silversheen	lb.	.08 /	
Pecan shell flour	ton	80.00 /	100.00
Stan white 325	ton	10.50 /	12.00
Walnut shell flours:			
100W, 200WD	ton	46.00 /	56.00
100WD	ton	40.00 /	50.00
200W	ton	56.00 /	66.00
200WB	ton	59.00 /	69.00
325W	ton	70.00 /	80.00
Hi-Sil 101	lb.	.10 /	
233	lb.	.09 /	
Hydrite	ton	22.50	
Flat	ton	22.50	
PD-10	ton	46.50	
Kalite	ton	50.00 /	65.00
Kaolloid	ton	10.50	
Laminar	lb.	.015	
McMamee Clay	ton	13.50 /	33.00
Multifex MM	ton	110.00 /	125.00
Nytal 200L	ton	27.00 /	50.00
300	ton	37.00 /	60.00
Secco Clay	ton	12.00	
Silene EF	lb.	.06 /	
Sno-Brite Clay	ton	12.50	
Snowflake	ton	20.00	
Surfex MM	ton	37.00 /	82.00
Suspenso	ton	33.00 /	48.00
Tamms Satin Talc	ton	22.50 /	46.00
Velveteen R Silica	ton	23.00 /	28.00
Witcarb P	ton	110.00 /	140.00
R	ton	120.00 /	150.00
Regular	ton	56.75 /	85.00
Wollastonite F-1	ton	23.00 /	25.00
P-1	ton	25.00 /	27.00

Finishes

Toy Gloss T-11 H	gal.	2.75 /	4.45
Logoquant colors	gal.	3.35 /	11.95
Silk screens	gal.	1.50 /	6.11
Logoset Series W	gal.	1.72 /	7.64

Flame-Proofing Agents

IC-776 Antimony Concentrate	lb.	.493 /	.51
M&T Antimony oxide	lb.	.27 /	.285

Lubricants

Advawax 280	lb.	.365 /	.39
Baselube or Toplube	qt.	2.50 /	4.00
Bomb-Lube	20 oz.	1.75 /	2.50
DC-36 Emulsion	lb.	1.36 /	2.50
Garalease 915	gal.	3.80 /	4.50
HSC #35, 362, 515	lb.	1.26 /	1.80
IC-500	gal.	2.50	
-571	gal.	3.25	
-793-10	gal.	3.40	

...-Lease	gal.	4.15 /	4.85
...1 Mold Release	lb.	3.00 /	4.00
...easap barium stearate	lb.	.37 /	.42
...Calcium 627	lb.	.36 /	.41
...Stearate	lb.	.35 /	.40
...Magnesium stearate	lb.	.38 /	.43
...A Separating Film	lb.	.30 /	.40
...ld Base Concentrate PCK	gl.	2.50 /	5.85
...ld Release 225	gal.	5.25 /	6.00
...225	gal.	6.00	
...Sil-Wix	gal.	4.00 /	6.00
...rt-A-Part	gal.	3.05 /	3.75
...ringkote 823	gl.	1.18 /	2.18
...Prepoxy	gal.	7.20 /	12.80
...kton 8406, 8407	lb.	.30 /	.37
...8416, 8417	lb.	.35 /	.42
...8429	lb.	.40 /	.47
...easor Wax No. 826	lb.	2.29	
...de	20 oz.	1.25 /	2.00
...ris	lb.	1.00 /	1.25
...-452	gal.	2.80 /	4.90
...olube	qt.	2.50 /	4.00
...bris-VPA Parting Agent	gal.	4.25 /	4.65

Mica

...ycalex 385 & 400, rods, 18-in. length		.90 /	3.35
Sheets, 14 x 18 inches		5.70 /	22.40
...K, rods, 18-in. length		1.80 /	6.70
Sheets, 14 x 18 inches		11.40 /	44.80
...pramica 500, rods, 18-in. length		1.08 /	4.02
Sheets, 14 x 18 inches		6.84 /	26.88

Miscellaneous

...tch Boy Bentone	lb.	.44 /	.60
...Ben-A-Gel	lb.	.98 /	1.40
...easap Water Proofing Agent 509	lb.	.21	
...MS Purging Compound	lb.	.35	
...tra violet absorber #9	lb.	5.25 /	5.75

Plasticizers

...dipol 2EH, 10A, 810, XX	lb.	.425 /	.435
...BCA	lb.	.45 /	.475
...ODV	lb.	.47 /	.50
...dmex 710	lb.	.325 /	.35
...711	lb.	.345 /	.37
...744, 745	lb.	.40 /	.425
...kron MP	lb.	.0305 /	.0755
...Barrett dibutyl phthalate	lb.	.30 /	.34
...Dimethyl phthalate	lb.	.275 /	.315
...Benzoflex 2-45	lb.	.26 /	.29
...9-88	lb.	.32 /	.35
Cadflex DDA, DI-OA, DOA, ODA	lb.	.425 /	.455
DDP, DI-OP, DOP, ODP	lb.	.305 /	.335
Di-BA	lb.	.4325/	.4625
Di-OZ	lb.	.48 /	.51
HS-10	lb.	.44 /	.47
TCP	lb.	.345 /	.375
Chlorowax 40	lb.	.1525/	.1825
50	lb.	.1675/	.1875
70	lb.	.185 /	.25
70-S	lb.	.21 /	.275
LV	lb.	.1725/	.2025
Columbian Carbon butyl stearate	lb.	.2275/	.3125
Capryl alcohol	lb.	.195 /	.295
Caprylene	lb.	.06 /	.16
Dibenzyl sebacate	lb.	.88 /	.965
Dibutyl phthalate, dihexyl phthalate	lb.	.30 /	.39
Dibutyl sebacate, CP	lb.	.64 /	.725
Dicapryl adipate, dihexyl adipate	lb.	.42 /	.51
Dicapryl phthalate	lb.	.295 /	.38
Dicapryl sebacate, dioctyl sebacate	lb.	.58 /	.665
Dihexyl sebacate	lb.	.62 /	.705
Diisooctyl phthalate, dioctyl phthalate	lb.	.305 /	.395
Dimethyl sebacate	lb.	1.25 /	1.335
Harchemex	lb.	.24 /	.34
Harflex 300	lb.	.58 /	.67
500	lb.	.315 /	.405
Methyl hexyl ketone	lb.	.26 /	.36
Sebacic acid, CP	lb.	.67 /	.79
Purified	lb.	.59 /	.71
Conoco H-300	lb.	.06 /	.10
Darex DIBA	lb.	.4325/	.4625
DIBM	lb.	.32 /	.3475
DIBP	lb.	.30 /	.33
DIDA, DIOA	lb.	.425 /	.455
DIDP, DIOP, DOP, DOP-HR, IOIDP	lb.	.305 /	.335
Dinopol 235	lb.	.355 /	.385
IDO	lb.	.305 /	.335
MOP	lb.	.325 /	.355
Dow Plasticizer No. 5	lb.	.315 /	.54
Resin 276-V2,-V9	lb.	.265 /	.325
Drapex 3.2	lb.	.40 /	.49
Dutch Boy Plasticizer NL-A10 (DBP)	lb.	.30	.33
NL-A20 (DOP), NL-A30 (DIOP)	lb.	.305 /	.335
NL-C20 (DOS)	lb.	.61 /	.63
NL-F21	lb.	.395 /	.425
NL-F31	lb.	.44 /	.47
NL-F41	lb.	.48 /	.51
NL-A56	lb.	.295 /	.325
Elastex, 10-P, 18-P, 28-P, 90-P	lb.	.305 /	.335
20-A, 60-A	lb.	.425 /	.455
40-P	lb.	.27 /	.30
50-B	lb.	.265 /	.295
80-P	lb.	.295 /	.325
DCHP	lb.	.59 /	.61
Ethox	lb.	.50 /	.525
Flexol 3GH	lb.	.44 /	.46
3G0	lb.	.53 /	.55
4G0	lb.	.325 /	.355
8N8	lb.	.355 /	.385
10-10, 810, CC-55, DOP	lb.	.305 /	.335
10-A, A-26	lb.	.425 /	.455
77-G, 426	lb.	.27 /	.30
B-400	lb.	.25 /	.28
R2H	lb.	.59 /	.595
TOF	lb.	.435 /	.475
Flexricin 66	lb.	.3275	
P-4		.30	
P-6	lb.	.37	
P-8	lb.	.32	
Good-rite GP-261	lb.	.305 /	.460
GP-233	lb.	.435 /	.585
Harchem Division's Harflex Series: 10	lb.	1.25 /	1.335
40	lb.	.64 /	.725
50, 80	lb.	.58 /	.665
60	lb.	.62 /	.705
90	lb.	.88 /	.965
120, 150	lb.	.305 /	.395
140, 160	lb.	.30 /	.39
180	lb.	.295 /	.38
220, 250	lb.	.425 /	.515
260, 280	lb.	.42 /	.51
300	lb.	.58 /	.67
500	lb.	.315 /	.405
Harchem butyl stearate	lb.	.2275/	.3125
Sebacic acid, CP	lb.	.67 /	.79
Purified	lb.	.59 /	.71
Kapsol	lb.	.3225/	.3525
KP-23	lb.	.29 /	.32
-90	lb.		
-140	lb.	.46 /	.485
-201	lb.	.5825/	.5925
-220	lb.	.31 /	.34
-555	lb.	.45 /	.475
Kronisol	lb.	.33 /	.355
Kronitex AA, I, K-3, MX	lb.	.345 /	.375
Methox	lb.	.385 /	.41
Monsanto dibutyl phthalate	lb.	.30 /	.33
Diethyl phthalate	lb.	.25 /	.28
Dimethyl phthalate	lb.	.275 /	.305
Diphenyl phthalate	lb.	.5175/	.5375
DIDA, DOA	lb.	.425 /	.455
DIDP, DIOP, DOP	lb.	.305 /	.335
HB-20	lb.	.15 /	.17
HB-40	lb.	.22 /	.24
Orthonitrobiphenyl	lb.	.13 /	.15
Tricresyl phosphate	lb.	.33 /	.36
Triphenyl phosphate	lb.	.39 /	.40
Morflex P-50	lb.	.68 /	.71
Naugatuck decylbutyl phthalate	lb.	.27 /	.30
Dibutyl phthalate	lb.	.30 /	.33
Sebacate	lb.	.645 /	.67
Diisooctyl adipate, dioctyl adipate	lb.	.425 /	.455
Diisooctyl phthalate, dioctyl phthalate, Isooctyl decyl phthalate	lb.	.305 /	.335
Dinonyl adipate	lb.	.445 /	.475
Dioctyl sebacate	lb.	.585 /	.61
Epoxy plasticizer	lb.	.335 /	.36
Tricresyl phosphate	lb.	.345 /	.375
Onia-Apex butyl oleate	lb.	.2325/	.26
Stearate	lb.	.22 /	.25
Diallyl phthalate	lb.	.4975/	.5225
Dibutyl phthalate	lb.	.30 /	.33
Dicapryl phthalate	lb.	.295 /	.325
Di-Carbitol phthalate	lb.	.40 /	.425
Diisobutyl adipate	lb.	.4325/	.4625
Diisodecyl phthalate	lb.	.305 /	.335
Dioctyl phthalate	lb.	.305 /	.335
D.I.O.P.	lb.	.305 /	.335
Tributyl phosphate	lb.	.50 /	.53
Ohspex Q-10	lb.	.295 /	.325
R-9	lb.	.3525/	.3775
Paraplex G-60, G-61	lb.	.3251/	.35
Pfizer acetyl tributyl citrate, tech.	lb.	.32 /	.57
Acetyl triethyl citrate, tech.	lb.	.36 /	.57
Triethyl citrate	lb.	.4575/	.58
Plasticiser 1	lb.	1.17 /	1.37
Plasticizer 120	lb.	.44 /	.60
Plastoflex §3	lb.	.52 /	.57
§520	lb.	.36 /	.435
D B E	lb.	.50 /	.55
MGB	lb.	.29 /	.37
VS	lb.	.3575/	.3975
Plastolein 9050 DHZ	lb.	.52 /	.56
9055 DGP	lb.	.28 /	.32
9057 DIOZ	lb.	.48 /	.52
9058 DOZ	lb.	.48 /	.52
9250 THFO	lb.	.3575/	.3975
9404 TGP	lb.	.3775/	.4175
9715 & 9720 Polymeric	lb.	.37 /	.41
Polyciser 162, 562, 662	lb.	.305 /	.335
332, 532, 632	lb.	.425 /	.455
PX-104	lb.	.30 /	.33
-108, -118, -120, -138	lb.	.305 /	.335
-114	lb.	.27 /	.30
-208, -220, -238	lb.	.425 /	.455
-404	lb.	.045 /	.07
-438	lb.	.585 /	.61
-800	lb.	.325 /	.35
-917	lb.	.33 /	.36
Pycal 40	lb.	.3875/	.4375
60	lb.	.60 /	.635
62	lb.	.80 /	.835
94	lb.	.3275/	.3775
140	lb.	.35 /	.40
170	lb.	.275 /	.325
194	lb.	.2775/	.3275
R C Plasticizers: B-17	lb.	.21 /	.33
BD-8	lb.	.38 /	.50
BIDP	lb.	.27 /	.42
DBP	lb.	.30 /	.44
DIDA, DIOA, DOA	lb.	.425 /	.56
DIDP, DIOP, DOP, ODP	lb.	.305 /	.45
DIOS, DOS	lb.	.58 /	.71
O-16	lb.	.275 /	.395
TG-8	lb.	.31 /	.43
TG-9	lb.	.41 /	.53
Santicizer 1-H	lb.	.50 /	.51
3	lb.	.46 /	.47
8	lb.	.43 /	.44
9	lb.	.39 /	.42
140	lb.	.33 /	.36
141	lb.	.34 /	.37
160	lb.	.25 /	.28
601	lb.	.32	
602	lb.	.305	
B-16	lb.	.4875/	.4975
E-15	lb.	.5075/	.5375
M-17	lb.	.4275/	.4575
Staflex AX	lb.	.43	
BR	lb.	.26 /	.29
CP	lb.	.28 /	.31
DBES, DOS	lb.	.61 /	.635
DIOA, ODA	lb.	.435 /	.465
DIOP, DOP, MP	lb.	.305 /	.335
DOZ	lb.	.48 /	.5075
IXA	lb.	.32 /	.35
KA	lb.	.36 /	.3875
KD	lb.	.44 /	.4675
Witciser §100	lb.	.26 /	.27
§101	lb.	.31 /	.32
§200	lb.	.195 /	.205
§201	lb.	.235 /	.245
§300	lb.	.30 /	.33
§312, 313	lb.	.305 /	.33
§412	lb.	.435 /	.465

Resins & Molding Compounds

Acrylic

Cadco cast rods	lb.	1.42 /	6.96
Polished	lb.	1.58 /	7.16
Machined rods	ft.	22.00 /	89.54
Tubes	lb.	1.39 /	5.76
Polished	lb.	1.51 /	5.99
Colors	lb.	1.62 /	5.99
Pearl	lb.	1.99 /	6.76
Lucite injection molding powders: Colorless, transparent	lb.	.55	
Std. colors	lb.	.59 /	1.00
Stock colors	lb.	.59 /	.84
Granular Powders for compression & extrusion	lb.	.51 /	.75
Plexiglas molding powders: Colorless	lb.	.55 /	.80
Colors, stock	lb.	.59 /	.84
Custom	lb.	.59 /	1.00
Sheets, Types I-A & II Colorless	sq. ft.	.80 /	22.18
Colors	sq. ft.	.88 /	1.10
Type R, Colorless	sq. ft.	.60 /	12.64
Colors	sq. ft.	.69 /	1.07
Polycast 1	sq. ft.	.80 /	2.40

Alkyd

Plaskon foundry resin 580-11L	lb.	.245 /	.275
Molding compound, Type 411	lb.	.43 /	.60
Type 413, 417	lb.	.57 /	.74
Type 420 black	lb.	.44 /	.695
Type 422 colored	lb.	.51 /	.695
Mottle	lb.	.52 /	.705
Natural	lb.	.49 /	.60
Type 430	lb.	.34 /	.50

Cellulosic

Cellulose acetate: Ampacet Group I	lb.	.30 /	.39
Group II	lb.	.46 /	.55
Group III			
Colors	lb.	.50 /	.59
Metallic	lb.	.63 /	.71
Pearl	lb.	.59 /	.68
Phosphorescent	lb.	.80 /	.89

Celanese film rolls			
Clear	lb.	.64 /	.87
Colors	lb.	.88 /	1.74
Sheets			
Clear	M. sq. in.	.032 /	.107
Colors	M. sq. in.	.042 /	.141
Forticel, plain colors	lb.	.63 /	.71
Reprocessed blacks	lb.	.51 /	.58
Lumarith molding cmpds.,			
Group I	lb.	.50 /	.59
Group II	lb.	.46 /	.55
Group III	lb.	.36 /	.45
Sheeting, extruded, non-stock			
Clear	M. sq. in.	.14 /	1.89
Colors	M. sq. in.	.16 /	2.07
Stock, clear	M. sq. in.	.14 /	1.62
Colors	M. sq. in.	.16 /	1.62
Cast, rolls			
Matte	M. sq. in.	.179 /	.648
Tinted	M. sq. in.	.239 /	.708
Sheets, clear	M. sq. in.	.141 /	1.52
Matte	M. sq. in.	.203 /	.788
Tinted	M. sq. in.	.255 /	1.72
Hercocel A, extrusion & injection	lb.	.50 /	.65
Injection, std colors	lb.	.46 /	.61
Special colors	lb.	.42 /	.45
Tenite Acetate, Group 1	lb.	.50 /	.59
Group 2	lb.	.46 /	.55
Group 3	lb.	.41 /	.51
Group 4	lb.	.38 /	.49
Group 5	lb.	.65 /	.75
Cellulose acetate butyrate:			
Tenite butyrate	lb.	.62 /	.71
A pearls	lb.	.72 /	.81
Blacks, reprocessed	lb.	.50 /	.58
Ethyl cellulose:			
Dyeform 720, 721	lb.	1.29 /	1.52
Ethocel P. G.	lb.	.72 /	.80
Bulk, reg.	lb.	.66 /	.81
Std., 7 cps.	lb.	.71 /	.86
Hercocel E	lb.	.72 /	.88

Epoxy

Araldite 502, 6010, 6020	lb.	.80 /	.995
504	lb.	.77 /	.965
551, 6060	lb.	.75 /	.95
6030, 6040	lb.	.885 /	.995
Bakelite ERL series	lb.	.80 /	.995
Epocast 2, 3, 5	lb.	1.33 /	1.77
4-B-2, 4-B, 4-C, 4-C-T, 4-D, Paste	lb.	1.15 /	1.55
Epon 562	lb.	1.52 /	1.77
815	lb.	.80 /	.99
820, 828	lb.	.80 /	.97
834	lb.	.855 /	1.00
864	lb.	.91 /	1.06
864-C-75	lb.	.73 /	.85
1001	lb.	.615 /	.85
1004	lb.	.595 /	.6025
1007	lb.	.605 /	.6125
1009	lb.	.69 /	.6975
Furane CN-502	lb.	1.33 /	1.77
Jet-Kote (with cat.)	gal.	7.50 /	10.00
Rezolins A & B	lb.	1.29 /	1.74
Toolplastik packages:			
L-900, L-930	lb.	1.59 /	2.29
L-902	lb.	1.69 /	1.84
L-904	lb.	1.54 /	2.19
L-910	lb.	1.94 /	2.34
L-914	lb.	1.83 /	2.19
L-931	lb.	1.75 /	1.99
L-940	lb.	2.05 /	2.29

Fluorocarbon

Bakelite FGBB-33789, FGEB-34790, FXMA-50590, FXMB-50344	lb.	9.00 /	10.00
FGEB-32788, FXMB-50090	lb.	12.00 /	14.00
FYTD	lb.	11.00 /	13.00
FYTH, FYTS	lb.	8.50 /	9.50
Kel-F Grade 270, 300			
High density	lb.	9.00 /	10.00
Low density	lb.	8.50 /	9.50
Grade 300-P25	lb.	10.00 /	11.00
Polyfluoron, high density crystals & pellets	lb.	9.00 /	9.50
Colors	lb.	9.50 /	10.00
Low density powder	lb.	8.50 /	9.00
Dispersion grade	lb.	10.50 /	11.00
Teflon powder, dispersion	lb.	7.00 /	7.75
Fine	lb.	9.50 /	11.00
General	lb.	5.10 /	5.75
Tape cylinder	lb.	5.35 /	6.00

Melamine

Fiberite 2016	lb.	.95	
Melmac 402	lb.	.51 /	.53
404R, 404T	lb.	.85 /	.95
405	lb.	.45 /	.52
428	lb.	.48 /	.55
430	lb.	.465 /	.535
440	lb.	1.10	
480	lb.	.265 /	.315
1077, 1079	lb.	.45 /	.75
Ungranulated	lb.	.43 /	.73
1500	lb.	.42 /	.55
1502	lb.	.45 /	.58
3020	lb.	.57 /	.72
3024-A	lb.	.67	
3135	lb.	.90 /	1.10
P-592, -592-A	lb.	.65 /	.75
Plaskon	lb.	.44 /	.75

Phenolic

91-LD	lb.	1.50 /	2.50
Admirex PL-50	lb.	.215	
UP-11	lb.	.2325	
Bakelite general purpose	lb.	.187 /	.3525
BMG-5000	lb.	.19 /	.30
Colors	lb.	.2375/	.435
Chem. resist.	lb.	.23 /	.40
Electrical Insul.	lb.	.2725/	.4125
Heat resist.	lb.	.19 /	.35
Impact resist.	lb.	.24 /	.4025
Barrett foundry resins,			
liquid	lb.	.2125/	.2425
Powdered	lb.	.27 /	.355
Insulation resins	lb.	.15 /	.175
Molding resin 313, 314, 317	lb.	.27 /	.285
316	lb.	.295 /	.31
1502, -3, -4, -5, R-110R	lb.	.25 /	.265
R-114	lb.	.285 /	.30
Corfoam 107, 114	lb.	.55 /	.82
Cyacor 151	lb.	.215 /	.235
191	lb.	.13 /	.16
Durez, heat resist.	lb.	.19 /	.245
Impact resist.	lb.	.24 /	.63
Insulation	lb.	.21 /	.305
Non-Bleed	lb.	.19 /	.195
Special	lb.	.19 /	.665
Std.	lb.	.19 /	.245
Durite GP	lb.	.195 /	.24
HR	lb.	.191 /	.3025
IM	lb.	.24 /	.415
SG	lb.	.195 /	.3575
Dyform	lb.	1.10 /	1.35
Fiberite 1078	lb.	.42 /	.43
1087, 1165, 1270, 1271, 1330, 1332, 1347, FM 1132, FM 3510	lb.	.39 /	.395
1153	lb.	.455 /	.46
1167	lb.	.3875/	.3925
1340	lb.	.4275/	.4325
1346	lb.	.44 /	.4475
4010	lb.	.68	
4020	lb.	.815 /	.82
FM 926	lb.	.43 /	.435
927	lb.	.41 /	.415
1914	lb.	.375 /	.38
1957	lb.	.445 /	.45
1996	lb.	.375 /	.38
10365	lb.	.5225/	.5275
11547	lb.	1.05 /	1.06
11678	lb.	.52 /	.525
14111	lb.	.415 /	.42
17067	lb.	.851 /	.82
17610	lb.	1.05 /	1.06
G-E 12368, 12374, 12392 shell molding resins	lb.	.26 /	.35
12401	lb.	.2975	
12408, 12460, 12486, 12490, 12491, 12493, 12853, 12875, 12883, 12885, 12886, 12900, 12901	lb.	.195 /	.20
12410, 12420	lb.	1.50	
12432	lb.	.395	
12433	lb.	.555	
12435	lb.	.24	
12439, 12466	lb.	.265	
12444	lb.	.425	
12462	lb.	.505	
12463	lb.	.405	
12467	lb.	.51	
12487, 12489, 12884, 12887	lb.	.355	
12494	lb.	.375	
12495	lb.	.245	
12808	lb.	.49	
12809	lb.	.65	
12817, 12882	lb.	.205 /	.21
12841	lb.	.2425	
Loven LHR-401, -403	lb.	.225 /	.23
-407, -409	lb.	.60 /	1.00
-408	lb.	.25 /	.255
L1201	lb.	.39 /	.40
-207	lb.	.475 /	.48
-209	lb.	.60 /	1.00
-212	lb.	.425 /	.43
LM-110, -119	lb.	.19 /	.195
-101	lb.	.24 /	.245
-116	lb.	.255 /	.26
-117	lb.	.225 /	.23
-118	lb.	.1975/	.2025
LMI-301	lb.	.2525/	.2575
-303	lb.	.345 /	.35
-304	lb.	.60 /	1.00
-307	lb.	.3075/	.3125
LMM-801, -803	lb.	.2125/	.2175
-804, -811	lb.	.245 /	.25
-807	lb.	.215 /	.22
Marblette casting resins	lb.	.50 /	.60
Plenco foundry resins	lb.	.27 /	.35
Molding cmpds. gen. purpose	lb.	.185 /	.235
Heat resist.	lb.	.19 /	.24
Improved impact	lb.	.225 /	.28
Min. bleed	lb.	.185 /	.195
Radio & TV	lb.	.20 /	.215
Stock	lb.	.205 /	.34
R-72S casting resin	lb.	.46 /	.74
Reilly general purpose	lb.	.195 /	.20
Heat & impact resist.	lb.	.20 /	.205
Resinox, gen. purpose, heat resist.	lb.	.19 /	.20
Impact	lb.	.245 /	.3125
Low elec. loss	lb.	.30 /	.355
Special	lb.	.20 /	.30
Rogers RX-425	lb.	.285 /	.30
-428	lb.	.348 /	.43
-429	lb.	.355 /	.42
-431	lb.	.4125/	.46
-438	lb.	.4575/	.46
-442	lb.	.3375/	.34
-447	lb.	.495 /	.50
-448	lb.	.345 /	.35
-458	lb.	.37 /	.37
-469	lb.	.355 /	.36
-525	lb.	.285 /	.29
-530	lb.	.4125/	.41
-625	lb.	.385 /	.39
Schenectady shell mold resins	lb.	.26 /	.28
Toolplastik No. 8000	lb.	.68 /	.72

Polyamide

G.M.I. Polyamide 115	lb.	.64 /	.77
Versamid 115	lb.	.66 /	.89
Zytel molding powder	lb.	/ 1.435	1.60

Polyesters

Acme 1-501	lb.	.82 /	.83
1-501A	lb.	.87 /	.88
1-503	lb.	2.75 /	3.50
1-510	lb.	.89 /	1.00
Atlac 363E-02Z, -12Z	lb.	.66 /	.69
-32Z	lb.	.68 /	.71
382E	lb.	.57 /	.60
FP	lb.	.66 /	.69
Bakelite Polyester resins	lb.	.35 /	.75
Celanese polyesters:			
CEL-101, Marcothix 1, 3	lb.	.50 /	.565
Marcothix 5, 7, 8	lb.	.46 /	.525
MR-28C, -28V, -37C, -37CX	lb.	.33 /	.395
MR-28CS	lb.	.35 /	.415
MR-28H, -41R	lb.	.36 /	.425
MR-28R, -36R	lb.	.34 /	.405
MR-28RL, -37RL	lb.	.355 /	.42
MR-30C	lb.	.44 /	.505
MR-31C, -31V	lb.	.37 /	.435
MR-33C	lb.	.53 /	.595
MR-40R	lb.	.38 /	.445
Diall 50-01, 50-51, 50-52	lb.	2.75 /	3.50
51-01	lb.	.87 /	.98
52-01	lb.	1.95 /	2.50
52-20-30	lb.	1.30 /	1.50
Fibercore 1000, 2000	lb.	.50 /	.65
3000	lb.	.55 /	.70
G-E polyesters			
AR 401	lb.	.35 /	.365
AR 403, 480	lb.	.34 /	.355
AR 403 LS, 480 LS	lb.	.355 /	.37
AR 493	lb.	.40 /	.415
AR 499	lb.	.435 /	.45
AR 501	lb.	.455 /	.47
Hetron	lb.	.43 /	.445
IC-312, -400, -514, -548, -625, -730, -800	lb.	.35 /	.385
-312-2	lb.	.365 /	.38
-336, -382, -706	lb.	.37 /	.385
-401	lb.	.44 /	.455
-420	lb.	.355 /	.37
-433	lb.	.38 /	.395
-636, -670	lb.	.48 /	.495
-638, -689	lb.	.55 /	.565
-670-2	lb.	.50 /	.515
-671	lb.	.405 /	.42
Filled resins	lb.	.255 /	.54
Laminac 4110	lb.	.33 /	.345
4111	lb.	.45 /	.465
4116	lb.	.33 /	.345
4120	lb.	.39 /	.405
4123, 4128	lb.	.34 /	.355
4134	lb.	.46 /	.475
4146	lb.	.43 /	.445
4192	lb.	.355 /	.37
4202	lb.	.55 /	.565
Mylar, rolls, types A & C	lb.	2.80 /	4.80
Type D	lb.	3.00 /	3.30
Sheets, type A	M. sq. in.	.09 /	1.11
Type C	M. sq. in.	.09 /	.15
Type D	M. sq. in.	.53 /	1.34
Plaskon 911, 920	lb.	.53 /	.665
941, 942, 951, 9411	lb.	.35 /	.465
943	lb.	.41 /	.525
9404	lb.	.365 /	.48
9406	lb.	.355 /	.465
9500, 9510, 9511	lb.	.35 /	.465
9600	lb.	.44 /	.555
Polycast 2	sq. ft.	1.89 /	5.18
3	sq. ft.	1.08 /	18.00
6	sq. ft.	.66 /	3.10
7	sq. ft.	.72 /	7.18
CR-39	sq. ft.	1.25 /	20.00
Pre-Imp	lb.	.68 /	.85
Thermaflow 100, 200, 300	lb.	.48 /	.82
400, 500	lb.	.52 /	.87
1,000, 2,300	lb.	.34 /	.55
2,400	lb.	.36 /	.58
Vibrin No. 112	lb.	.40 /	.515
114, 117, 118, 151, 152	lb.	.35 /	.465
115A	lb.	.38 /	.495
121	lb.	.46 /	.575
135	lb.	3.00	
142	lb.	.55 /	.665
152	lb.	.365 /	.48
X-1029	lb.	.35 /	.465

X-1035B	lb.	.62 /	.73
X-1633A	lb.	.49 /	.605
X-1636W	lb.	.385 /	.70
Polyethylene			
LC No. 6, 617	lb.	.30 /	.37
No. 6A, 7, 617A	lb.	.35 /	.42
No. 615, G-201	lb.	.38 /	.45
No. 629	lb.	.40 /	.47
No. 729	lb.	.45 /	.52
Marbon	lb.	.41 /	.505
Bakelite DE Series	lb.	.43 /	.725
DVGT	lb.	.54 /	.69
DVLT, DYNF, DYNH	lb.	.41 /	.59
DYNJ	lb.	.44 /	.62
DYNK	lb.	.45 /	.63
Catalin 15-5	lb.	.41 /	.59
Celanese polyethylene sheeting:			
Extruded rolls, 44 in. wide	lb.	.56 /	1.12
Sheets, 44 x 60 in.	sheet	.83 /	8.76
Petrothene 100	lb.	.43 /	.47
200	lb.	.41 /	.45
Poly-Eth 1003	lb.	.45 /	.59
1004, 1005, 1007, 1008.5, 2005, 2007, 2037, 2205, 2215, 2235	lb.	.41 /	.55
3215	lb.	.35 /	.49
4005	lb.	.43 /	.57
5003	lb.	.53 /	.68
Reynolon 1000, P series	lb.	.60 /	.80
Tenite Group 1	lb.	.41 /	.45
Group 2	lb.	.43 /	.47
Group 3	lb.	.46 /	.50
Group 4	lb.	.39 /	.43
Group 5, 6	lb.	.50 /	.72
Group 7	lb.	.60 /	.82
Group 8	lb.	.70 /	.92
Silicone			
Bakelite GMGA-5001, -5002	lb.	2.75 /	3.10
5003	lb.	4.00 /	4.35
5004	lb.	5.40 /	5.75
Styrenes			
Impact, crystal	lb.	.315 /	.335
Colors, std.	lb.	.345 /	.363
Special	lb.	.345 /	.75
Pearl	lb.	.41 /	.75
Phosphorescent	lb.	.695 /	1.00
Tinsel	lb.	.41 /	.67
Confetti	lb.	.51 /	.70
Bakelite BMC series, nat.	lb.	.45 /	.683
Colors	lb.	.50 /	.735
BMS, SMD series, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	.52
RMD series, nat.	lb.	.45 /	.683
Colors	lb.	.50 /	.735
TGD series	lb.	.33 /	.35
Colors, std.	lb.	.36 /	.38
Special	lb.	.36 /	1.00
TMD series	lb.	.33 /	.40
Colors, std.	lb.	.36 /	.43
Special	lb.	.36 /	1.00
Catalin, high impact, natural	lb.	.325 /	.355
Colors, std.	lb.	.355 /	.385
Special	lb.	.36 /	1.00
Medium impact, natural	lb.	.325 /	.355
Colors, std.	lb.	.355 /	.385
Special	lb.	.355 /	1.00
Regular grade, crystal	lb.	.305 /	.325
Colors, std.	lb.	.345 /	.365
Special	lb.	.345 /	1.90
Utility black	lb.	.18 /	.235
Cycolac 12769 A, 12877, 12968, 12982	lb.	.73 /	.81
12805	lb.	.65 /	.73
12830, 12967	lb.	.70 /	.78
12876 A	lb.	.69 /	.77
12981	lb.	.78 /	.86
12983	lb.	.76 /	.84
12984	lb.	.77 /	.85
13022	lb.	.72 /	.80
Natural Powder	lb.	.58 /	.66
Pellets nat. & std. colors	lb.	.65 /	.73
Darex Copolymer 3	lb.	.47 /	.67
43G	lb.	.39 /	.58
X34	lb.	.42 /	.61
Latices 3L	lb.	.415 /	.56
610L	lb.	.30 /	.46
3020	lb.	.32 /	.47
Dow Latex polystyrene	lb.	.30 /	.46
Latices, styrene/butadiene	lb.	.30 /	.44
Dylite, expandable beads	lb.	.50 /	.60
Koppers, Fiberstuff	lb.	.55 /	1.505
MC-185 series	lb.	.33 /	.355
-300 series	lb.	.33 /	1.005
-400 series	lb.	.355 /	1.005
Regular, crystal	lb.	.295 /	.315
Colors, std.	lb.	.335 /	.355
Special	lb.	.335 /	1.005
Pearl	lb.	.41 /	1.005
Phosphorescent	lb.	.695 /	2.005
Kristastic, std. colors	lb.	.50 /	1.10
Lustrex HI-Flow 55, crystals	lb.	.295 /	.31
HI-Test 88, std.	lb.	.36 /	.38
Special colors	lb.	.36 /	1.00
L, crystals	lb.	.295 /	.31
Colors std.	lb.	.335 /	.35
Special	lb.	.315 /	1.00
LHA, std.	lb.	.355 /	.375
Special	lb.	.355 /	1.00
Utility black, gen. purpose	lb.	.18 /	.185
High impact	lb.	.235 /	.24
Medium impact	lb.	.19 /	.195
Marbon resins	lb.	.39 /	.46
Plio-Tuf C75	lb.	.37 /	.40
G85	lb.	.52 /	.54
Polycast 4	sq. ft.	2.56 /	11.07
Styron 475, natural	lb.	.33 /	.35
Colors, std.	lb.	.36 /	.38
Special	lb.	.36 /	1.00
Sheets, std.	lb.	.55 /	.60
Special	lb.	.55 /	.62
480, natural black	lb.	.38 /	.40
Colors, std.	lb.	.41 /	.43
Special	lb.	.41 /	1.00
647, crystal	lb.	.305 /	.32
Colors, special	lb.	.345 /	1.34
666, 688, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
700, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
777 colors, std.	lb.	.355 /	.375
Special	lb.	.355 /	1.00
Urea			
Admirez Foundry Resins, SP-30	lb.	.27	
UP-50	lb.	.105	
Beetle C-4980, T-298	lb.	.1875/	.30
MUP series, powder	lb.	.30 /	.49
Special colors	lb.	.30 /	.59
Granules	lb.	.33 /	.52
Special colors	lb.	.33 /	.62
Plaskon molding cmpds.:			
Black & Brown	lb.	.1875/	.30
Other colors	lb.	.30 /	.62
Foundry resins, liquid	lb.	.10 /	.13
Powdered	lb.	.2325/	.2525
Sylplast molding cmpds., granules	lb.	.33	
Powder	lb.	.30	
Vinyls			
Bakelite QG-5909	lb.	.35 /	.585
QG-5921	lb.	.41 /	.643
5924	lb.	.43 /	.665
QYNA, QYSM, QYSQ	lb.	.27 /	.47
QYNV	lb.	.30 /	.50
QYSJ	lb.	.28 /	.48
VG-1914, 1918	lb.	.37 /	.605
1985	lb.	.35 /	.585
5507	lb.	.31 /	.545
5544	lb.	.405 /	.64
5911	lb.	.315 /	.55
5980	lb.	.32 /	.555
7734	lb.	.28 /	.515
9031	lb.	.265 /	.50
9530	lb.	.275 /	.51
9960, 9970, 9980	lb.	.335 /	.57
VAGH	lb.	.55 /	.75
VMCH	lb.	.41 /	.61
VYDR, VYNW	lb.	.27 /	.47
VYHH	lb.	.32 /	.52
VYLF	lb.	.36 /	.56
VYNS	lb.	.44 /	.64
VYNV	lb.	.32 /	.52
Blacar No. BW-60	lb.	.315 /	.385
NEMA colors	lb.	.355 /	.425
No. BW-80	lb.	.405 /	.455
NEMA colors	lb.	.445 /	.495
No. PC white, ivory, black	lb.	.285 /	.335
Other colors	lb.	.325 /	.375
Darex Everplex A (wet wt.)	lb.	.21 /	.39
B (wet wt.)	lb.	.22 /	.40
G (wet wt.)	lb.	.21 /	.39
Copolymer Y (wet wt.)	lb.	.245 /	.28
PVA Emulsions (wet wt.)	lb.	.19 /	.355
Diamond PVC-45, -50	lb.	.38 /	.44
Dow PVC-100, -111	lb.	.38 /	.57
Exon 402A, 500, 905, 915, 925	lb.	.31 /	.51
450, 468R, 480	lb.	.35 /	.55
461	lb.	9.75	
468	lb.	.33 /	.53
470	lb.	.55	
471	lb.	.50	
654	lb.	.34 /	.54
Formvar	lb.	.865 /	1.03
Gelva emulsions	lb.	.19 /	.205
Granules	lb.	.4175/	.6175
Geon 101, 101EP, 103EP, 202	lb.	.27 /	.45
121	lb.	.30 /	.48
126	lb.	.28 /	.46
400X110	lb.	.41 /	.59
404HI	lb.	.37 /	.55
409, 426, 427, 428	lb.	.32 /	.50
503H (polyblend)	lb.	.425 /	.525
2042, 2046	lb.	.315 /	.55
Colors	lb.	.365 /	.60
6373	lb.	.345 /	.58
Colors	lb.	.395 /	.63
6461	lb.	.325 /	.56
Colors	lb.	.375 /	.61
8372	lb.	.33 /	.565
Colors	lb.	.38 /	.615
8539, 8726	lb.	.33 /	.565
Colors	lb.	.35 /	.585
8590, 8591, 8592, 8593, 8594, 8595	lb.	2.00 /	2.75
8600	lb.	.275 /	.51
Colors	lb.	.325 /	.56
8620	lb.	.27 /	.505
Colors	lb.	.32 /	.555
8630	lb.	.425 /	.66
Colors	lb.	.475 /	.71
8640	lb.	.35 /	.585
8650	lb.	.32 /	.555
8677	lb.	.435 /	.67
8700A, 8750	lb.	.425 /	.66
Colors	lb.	.455 /	.69
8720	lb.	.605 /	.84
8737	lb.	.33 /	.565
8740	lb.	.295 /	.53
8749	lb.	.29 /	.525
8800	lb.	.44 /	.675
8801	lb.	.275 /	.51
Colors	lb.	.325 /	.56
8802	lb.	.33 /	.565
Colors	lb.	.38 /	.615
8804	lb.	.29 /	.525
8807	lb.	.45 /	.685
8809	lb.	.37 /	.605
8810	lb.	.275 /	.51
8812, 8813, 8814, 8815	lb.	.315 /	.55
Latex 151, 251	lb.	.315 /	.55
351	lb.	.34 /	.75
352	lb.	.31 /	.75
552, 450x157	lb.	.39 /	.75
576	lb.	.36 /	.75
652	lb.	.37 /	.75
Krene, film	lb.	.505 /	.655
Sheeting	lb.	.49 /	.645
Marvinols:			
NF-1005	lb.	.34 /	.625
NF-1055, 3520	lb.	.275 /	.56
NF-3020	lb.	.41 /	.645
NF-3025	lb.	.38 /	.665
NF-3040	lb.	.3375/	.6225
NF-3045, 3050	lb.	.37 /	.605
NF-3055	lb.	.285 /	.57
NF-3060	lb.	.29 /	.575
NF-3065	lb.	.30 /	.585
NF-3070, 3075, 3080	lb.	.265 /	.50
NF-3085, 3090, 3095	lb.	.29 /	.525
NF-3505, 3515	lb.	.36 /	.595
NF-3510	lb.	.34 /	.575
NF-4005	lb.	.44 /	.675
NF-4010, 4015, 4020	lb.	.42 /	.705
NF-5015, 5020	lb.	.40 /	.655
NF-5025	lb.	.33 /	.585
NF-5030	lb.	.29 /	.545
NR-6015	lb.	.39 /	.685
NR-6020	lb.	.39 /	.675
NR-7020, 7045, 7060	lb.	.50 /	.735
VR-10	lb.	.30 /	.47
VR-12, -20, -21, -22, -24, -30	lb.	.29 /	.46
VR-50	lb.	.32 /	.49
Opalon 300, 300FM	lb.	.31 /	.51
410	lb.	.34 /	.54
505	lb.	.35 /	.55
Inj. molding cmpds.	lb.	.29 /	.67
Profile extrusion cmpds.	lb.	.29 /	.72
Wire cmpds.	lb.	.29 /	.67
Plastiflex, std.	lb.	.90 /	1.10
Novelty	lb.	1.15 /	1.80
Pliovic AO (dispersion)	lb.	.30 /	.32
DB80V, DB90V, EDB90V	lb.	.27 /	.29
Latex 300	lb.	.30 /	.35
Reynolon, 4000 series	lb.	1.55 /	2.30
Rolls, 1-mil	sq. yd.	.0625/	.11
Colors	sq. yd.	.0675/	.08
4-mil	sq. yd.	.215 /	.3125
Colors	sq. yd.	.2375/	.255
16-mil	sq. yd.	.81 /	1.19
Colors	sq. yd.	.86 /	.945
Satinflex	lb.	1.15 /	1.80
Vinylidine			
Dow Latex 744-B	lb.	.30 /	.46
Saran formulation 115, black, nat.	lb.	.39 /	.52
Colors	lb.	.44 /	.69
720 nat.	lb.	.41 /	.54
Colors	lb.	.46 /	.71
747 nat.	lb.	.395 /	.525
761 nat.	lb.	.39 /	.52
Colors	lb.	.44 /	.69
820 nat.	lb.	.42 /	.55
Colors	lb.	.47 /	.60
Latices	lb.	.45 /	.61
Resin F 120	lb.	.58 /	.65
Solvents			
Enjay acetone	lb.	.08 /	.115
Isopropyl acetate	lb.	.105 /	.14
Methylethyl ketone	lb.	.115 /	.15
Secondary butyl acetate	lb.	.1125/	.1475
Butyl alcohol	lb.	.115 /	.15
Petrohol 91%	gal.	.37 /	.60
95%	gal.	.39 /	.62
99%	gal.	.41 /	.64
Stabilizers			
Advastab B-13-P, BC-105, XBC-147	lb.	.75 /	.80
BC-12, C-77, E-82, XC-79, XC-143	lb.	.90 /	.95

BC-74, XBC-30	lb.	.70 /	.75
C-21	lb.	1.00 /	1.05
CH-20, CH-49	lb.	.60 /	.65
JCX	lb.	.62 /	.67
L paste, Z-6	lb.	.65 /	.70
SN	lb.	.47 /	.52
T-10, T-52	lb.	1.90 /	1.95
T-17M	lb.	2.95 /	3.00
T-50LT, T-72	lb.	3.20 /	3.25
T-671	lb.	2.65 /	2.70
XE-98	lb.	.53 /	.58
Barca 10	lb.	.75 /	.80
Baker barium ricinoleate	lb.	.70	
Calcium ricinoleate	lb.	.55	
Zinc ricinoleate	lb.	.60	
Dutch Boy Barinac	lb.	.70	
Calstar	lb.	.37	
Clarite A	lb.	.83	
B	lb.	.68	
CS-137	lb.	1.25	
DS-207	lb.	.55	
Dyphos	lb.	.58 /	.595
50A	lb.	.34	
Dythal	lb.	.395 /	.41
Leadstar	lb.	.39	
Lectro 60	lb.	.2525	
Normal lead maleate	lb.	.4475	
Normasal	lb.	.46	
Pearlescent pigment	lb.	1.00	
Plumb-O-Sil-A	lb.	.3075	
-B	lb.	.325 /	.37
-C	lb.	.3475/	.375
Provinite A	lb.	.83	
B	lb.	.68	
Tribase	lb.	.275	
-E	lb.	.2225	
Trimal	lb.	.435	
Ferro 182	lb.	.70 /	.76
200	lb.	1.31 /	1.43
203, 900, 1820	lb.	.88 /	1.00
503	lb.	.28 /	.40
541A	lb.	.80 /	.92
700	lb.	.47 /	.59
703, 1972	lb.	.63 /	.75
823	lb.	2.50 /	2.75
840	lb.	3.25	
903	lb.	.58 /	.70
909	lb.	.91 /	1.01
1203	lb.	1.30 /	1.40
1206	lb.	1.23 /	1.33
1212	lb.	.68 /	.80
1825	lb.	.98 /	1.10
1840	lb.	.73 /	.85
Harshaw 1-V-3	lb.	.43	
1-V-4	lb.	.68	
1-V-7	lb.	.66 /	.71
2-V-4	lb.	.85 /	.90
2-V-7	lb.	1.10 /	1.15
2-V-8	lb.	1.30	
2-V-400	lb.	.80 /	.85
5-V-1	lb.	.41	
5-V-22	lb.	.49	
7-V-1	lb.	.90 /	.95
7-V-2	lb.	.95 /	1.00
7-V-4	lb.	1.18 /	1.23
8-V-1	lb.	1.10 /	1.15
8-V-5	lb.	.80 /	.85
8-V-100	lb.	.84 /	.89
9-V-1	lb.	.76 /	.81
12-V-5	lb.	.75	
22-V-1	lb.	1.28	
24-V-1	lb.	1.28 /	1.33
28-V-2	lb.	1.18	
128-V-5	lb.	.86	
281-V-4	lb.	.90	
Merix AST Concentrate 1001	lb.	.355 /	1.75
Metasap 613-A	lb.	.69	
613-B	lb.	.84	
613-C	lb.	1.06	
621	lb.	.88	
624	lb.	.75	
Cadmium stearate	lb.	1.40 /	1.44
Fused stearates, calcium			
602-A	lb.	.25 /	.30
Dibasic lead stearate	lb.	.56	
Lead 611	lb.	.32 /	.37
Lead stearate	lb.	.39 /	.44
Nuostable V-1	lb.	.54 /	.59
V-2	lb.	.39 /	.44
V-10	lb.	.70 /	.75
V-20	lb.	1.30 /	1.35
V-21	lb.	1.29 /	1.34
V-30	lb.	.90 /	.95
V-31	lb.	.80 /	.85
V-40	lb.	1.18 /	1.23
V-42	lb.	.65 /	.70
V-43	lb.	.75 /	.80
V-44	lb.	.90 /	.95
V-45	lb.	1.10 /	1.15
V-50	lb.	.49 /	.54
V-60	lb.	.37 /	.42
V-70	lb.	.68 /	.73
V-80	lb.	2.80 /	2.85
V-81	lb.	2.90 /	2.95
Permyl A	lb.	.45 /	.57
Stabelan 110, 120	lb.	.65 /	.75
115, HR paste	lb.	.85 /	.95
E	lb.	1.35 /	1.50
HR-50	lb.	.75 /	.90
HR liquid	lb.	.65 /	.75
Powder	lb.	.95 /	1.05
XL	lb.	.55 /	.65
Stabilizer #3, 52	lb.	1.90 /	2.00
17-M	lb.	3.00 /	3.25
#42	lb.	.83 /	.93
89-X	lb.	.75 /	.80
#143	lb.	.80 /	.90
A-5	lb.	1.25	
BC-12	lb.	.87 /	.95
BC-105	lb.	.75 /	.85
C-2	lb.	1.65	
C-77	lb.	.85 /	.95
CH-14	lb.	.63 /	.70
CH-20	lb.	.63 /	.68
D-22	lb.	1.99 /	2.05
E-6-B	lb.	.80 /	.90
E-49	lb.	.60 /	.65
E-98	lb.	.55 /	.65
JCX	lb.	.62 /	.68
L-Paste	lb.	.60 /	.68
Mark E	lb.	.72 /	.83
M	lb.	.73 /	.83
PL	lb.	.74 /	.84
TT	lb.	.77 /	.91
V	lb.	.91 /	1.04
X	lb.	2.50 /	2.75
XI	lb.	.87 /	1.01
XV	lb.	.92 /	1.01
XX	lb.	.63 /	.74
OM-10	lb.	1.90 /	2.00
-18	lb.	3.10 /	3.35
P-1835	lb.	3.20 /	3.35
PS-38	lb.	.50 /	.65
SN	lb.	.47 /	.53
T-72	lb.	3.20 /	3.35
V-I-N	lb.	.40 /	.48
VL-3	lb.	.95 /	1.00
Stafiex QMXA	lb.	.70	
50% in DOP	lb.	.52	
OY	lb.	1.80 /	1.90
Stayrite #10	lb.	.33 /	.37
#15	lb.	.54 /	.57
#20	lb.	.38 /	.43
#22	lb.	1.32 /	1.36
#25	lb.	.36 /	.40
#70, 75, 80, 90	lb.	.69 /	.70
#229	lb.	.47 /	.50
P-10	lb.	.40 /	.44
Thermolite 12	lb.	2.00 /	2.25
13	lb.	3.10 /	3.70
15	lb.	4.13	
17	lb.	2.45 /	2.75
20	lb.	2.95 /	3.25
39	lb.	2.75 /	3.25
91	lb.	3.00	
Vanstay C, S	lb.	.63 /	.65
HT	lb.	.90 /	.92
L	lb.	.33 /	.35
R	lb.	.70 /	.72

Wetting Agents

Advawet X-212	lb.	.50 /	.55
Poly-lube No. 4	gl.	1.45 /	1.90